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ITEM ANALYSIS PROGRAM (IAP) FOR ACHIEVEMENT TESTS.(U)
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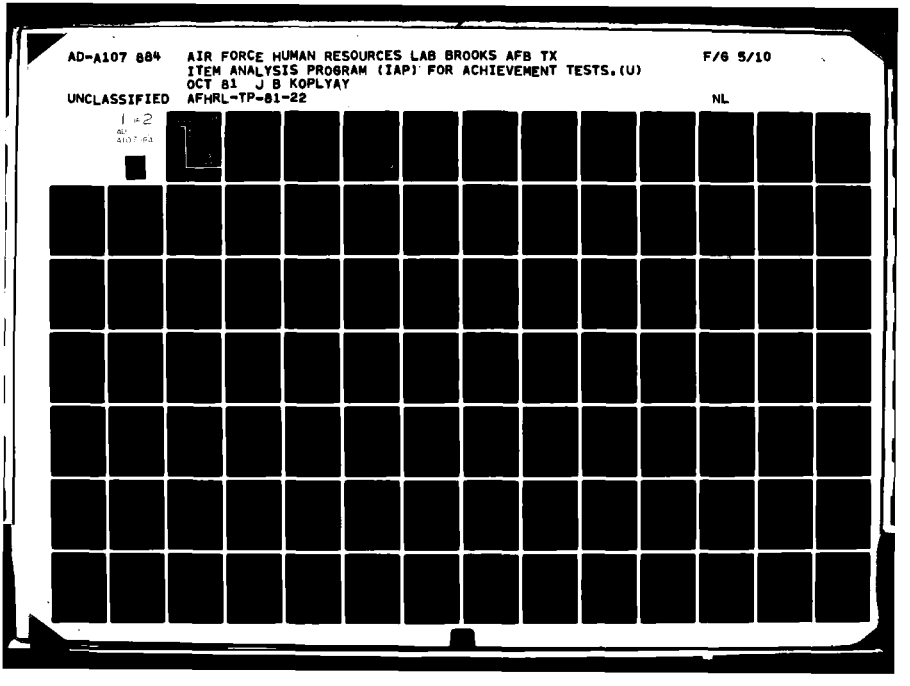

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LEVEL II

AIR FORCE HUMAN RESOURCES LABORATORY

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ITEM ANALYSIS PROGRAM (IAP) FOR ACHIEVEMENT TESTS

By

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Brooks Air Force Base, Texas 78235

October 1981

AIR FORCE SYSTEMS COMMAND
BROOKS AIR FORCE BASE, TEXAS 78235

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20 ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

IAP is a computer-based, versatile and powerful item analysis package. The input consists of responses to achievement type items. The output provides item/test parameters together with the parameters of the fitted normal ogive: X 0 and β. Among the many features, IAP can analyze multiple-response items and factor analyze the test for multidimensionality, and can be used for both power-test and speed-test.

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AFHRL Technical Paper 81-22 October 1981

ITEM ANALYSIS PROGRAM (IAP) FOR ACHIEVEMENT TESTS

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This publication is presented as a working paper.
It is published solely to document work performed.

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I. INTRODUCTION

The traditional approximations, formulas, and techniques used in item analysis (Kelley, 1939) were geared to save computational labor at the expense of accuracy and amount of information about achievement tests, items, and the individuals taking the test. In view of the available assistance of modern high speed computers it became possible to develop a more sophisticated, accurate and detailed mathematical approach (Baker, 1964, 1965) which provides test constructors with more flexibility, greater accuracy, and detailed additional information necessary to improve the evaluation and hence the quality of the items and tests.

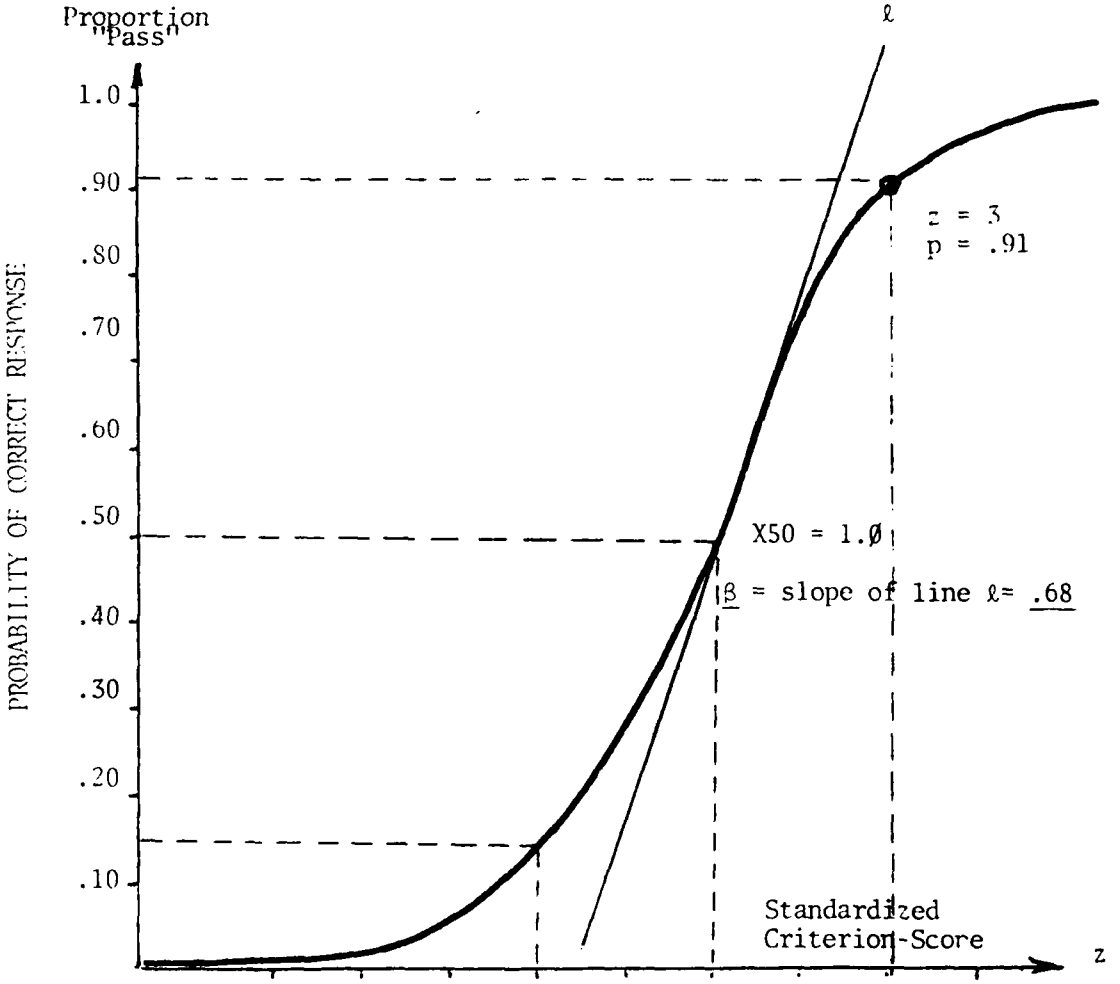
This paper describes the technical details that are required for the use of the IAP program as it is operational on a UNIVAC 1100/81 computer system at the Manpower and Personnel Division of the Air Force Human Resources Laboratory, Brooks Air Force Base, Texas. The basic concepts and general information are first provided. Detailed instructions for the preparation of IAP control cards by the user are provided in the next section. The appendices contain the computational formulas used, mathematical derivations including some proofs, and a sample run.

Basic Concept of IAP

The basic concept in modern item analysis is the item characteristic curve (Binet and Simon, 1916) and its associated parameters (Tucker, 1946). The curve is essentially a line fitted through the points obtained by plotting the proportion of respondents to a particular item

or item-alternative against a given criterion score or "ability-score" expressed in standard z-scores. Figure 1 is an example of such an item characteristic curve. This curve is a cumulative distribution function of two parameters, X50 and β. Fitting a normal ogive through the points, X50 is the point at which 50% of the respondents passed the item. The corresponding z-score is the "ability" at which the item discriminates the best. Beta (β) is an indicator of the strength of discrimination; i.e., the larger the β, the sharper the discrimination. Beta is conceptually the slope of the line drawn to the item characteristic curve at the point X50. Mathematically it can be shown that $\beta = 1/\sigma$; i.e., the reciprocal of the standard deviation of the normal ogive. The use of X50 and β provides the scientist with great versatility and flexibility. They enable one to draw specific inferences about a given individual and a given item, choose items which have optimum discrimination power at a certain ability level, screen-off a certain percent of a group of examinees, estimate the "true score" of an individual, and compute the probability of the correct response. The advantages are so numerous and broad that only through use can the program be fully realized and understood. Two of the many applications are briefly discussed below, referencing Figure 1.

Figure 1 EXAMPLE OF A TYPICAL ITEM CHARACTERISTIC CURVE
X50 = 1.0, β = .68, ITEM DIFFICULTY = .44 .



	-2	-1	0	+1	+2	+3	
Total number of Respondents for this item	25	43	73	80	74	23	318 *
Respondents who passed this item	1	6	19	40	54	21	141 *
Corresponding proportions passing the item	1/25 =.04	6/43 =.14	19/73 =.26	40/80 =.50	54/74 =.73	21/23 =.91	

* ITEM DIFFICULTY = $\frac{141}{318}$ = .44

1. Probability of a correct response

The probability of correct response of an individual for the given item can be read directly from Figure 1 providing that the individual's criterion score is known. For example, the probability of a correct response for a respondent with z=3 (abscissa value) is .91.

This probability can also be computed knowing X50, β, and z-score as follows (using X50 and β from Figure 1):

$$z = \beta(\text{z score} - X50)$$

$$= .68\ (3 - 1) = 1.36$$

From a cumulative normal distribution table, the area corresponding to z = 1.36 equals approximately .91.

Thus, the probability that the individual with a criterion score z = 3 will pass this item is P = .91.

Similar computations may be carried out for respondents with any given criterion score. Figure 1 shows these probabilities (proportions) for various standardized criterion scores (z-scores).

2. Selecting a certain percent of the examinees

Suppose an achievement test is administered to a group of individuals and subsequent item analysis provides the standard deviation (in standard score) of the test and, among other information, the X50 values for each item. Furthermore, suppose that the upper 16% of the examinees is desired to be selected from the rest of the group.

This can be accomplished by choosing items with certain X50 values. The upper 16% represents an area of (100-16) = 84 percent. The corresponding standard score in the cumulative normal frequency distribution table is z = 1.0. The items to be chosen should be those which have X50 = (1.0) σ. If σ = 1.5, the items should have X50 = z. σ = (1)(1.5) = 1.5.

The maximum number of discriminations occur at the point at which 50% of the examinees pass the item; i.e., between 84% and 100% in the above example; thus, the upper 16% is selected by maximum discrimination.

The traditional item-analysis technique provides only the item difficulty in terms of proportion of the total respondents who choose a particular response, and the item-criterion correlation, and no information is available describing how a particular item or item-alternative functioned.

II. DESCRIPTION OF THE IAP PROGRAM

General Information

The criterion upon which the program bases all the statistical analyses is specified by the user. This criterion may be either internal or external.

The internal criterion is the total test score of each individual taking the test. These scores may be used as raw scores or may be corrected for guessing according to the user's specification. All item and test statistics are calculated accordingly. An exception is made in the case of the frequency distribution of an internal criterion, where the user may specify either raw score-distribution or corrected for guessing score-distribution regardless of the user's specification for the type of scores to be used in the item analysis. However, if the user specifies the computation of phi-coefficients, the exception previously mentioned is not available and both the phi and the frequency distribution are based on the same criterion used in the computation of item statistics.

The external criterion is furnished by the user. If an external criterion is specified on the control card, the program will use it in the item analysis. The validity coefficient between the external criterion and the internal criterion is calculated using raw scores or corrected scores depending upon the user's specification.

The test may be graded and analyzed as a power test or as a speed test. In the latter case, only those respondents reaching a particular item will be

considered in the analysis of that item, including the item difficulty and response distribution. In addition, the mean and standard deviation of the population reaching the item will be given. Since the X50 represents a z-score of the population reaching the item, it is not necessarily comparable to an X50 obtained on another item from a different population. An equivalent X50 is computed by making a z-score transformation from the "item population" to the total population:

$$\text{Equivalent } X50 = \frac{\sigma_i}{\sigma_t} \cdot X50 + \frac{\bar{X}_i - \bar{X}_t}{\sigma_t}$$

where σ_t = standard deviation of total population

σ_i = standard deviation of item population

$\bar{X}_t$ = mean of total population

$\bar{X}_i$ = mean of item population

X50 is based on the item population

This "Equivalent X50" is printed in the item analysis summary table.

The factor analysis is done on a tetrachoric inter-item correlation matrix. It is always based on the total number of cases regardless of whether or not all finished the test. An individual who does not reach an item is considered to have missed it in this portion of the program. The factor analysis is a principal component analysis with Verimax rotation and unit diagonal elements.

Computation of the tetrachoric matrix is the slowest part of the program, particularly if the number of items is large.

The test reliability is influenced by the sum of item variances $\sum_{i=1}^{N}(p_i q_i)$. Here, the proportion answering Item i correctly, p_i, is always based on all the cases. This makes interpretation of the reliability coefficient in the case of a speed test questionable. (The same can be said about the factor analysis part of the program.)

There is an option designed to handle test items for which there is more than one correct answer; in such cases the various responses receive different score points of credit. These items have alphanumeric responses in order to be able to handle a larger number of possible responses. This option would generally be used with multiple-response tests. The analysis of the items considers any credit achieved on an item as passing the item, and no credit at all as missing the item. This is rather arbitrary, and could be changed if desired. There is no correction for guessing on alphanumeric response items. The amount of credit to be received for a particular response to a particular item is read in on control cards (Card 5). This option could be used to weight responses differentially. Another option provides an Item Alternative Information Roster containing information about the validity and difficulty of each item-alternative. The validity is given as the point-biserial correlation between the particular alternative and the criterion. The difficulty is expressed as the proportion of the sample choosing a particular alternative. Additionally, the inter-correlation matrix of the alternatives within each item is provided.

Preparation of Input Data

The input may be either card or tape, as indicated on Control Card 1, Col. 44. The FORTRAN logical unit number for the input unit is to be specified in Col. 6-7 of Card 1.

The format for reading in the data is specified by the user (Card 3). The restrictions on the input data are as follows:

The ID variable must be either the first or the last word read, as specified on Card 1, Col. 36.

The external criterion must be the word immediately preceding the responses, if there is an external criterion.

The ID is read in by "A" format; the numeric responses by "I" format; and the alphanumeric responses (if any) by "A" format. The external criterion is read in by "F" format.

If an item is not attempted, it is to be coded "0" for both numeric and alphanumeric items. This is important for tests that are to be corrected for guessing.

On a speed test, the first relevant item after the last attempted item is to be coded a "9" if the item is a numeric response item, and a "W" if the item is an alphanumeric response item. (Items coded "0" on Card 4, which are not considered on the test, do not apply here. See write-up for Card 4.) If desired, all items following the last attempted item can be so coded.

Card or Tape Output

If desired, the following information can be listed on cards or tape:

Test ID, case ID, score, corrected score, external criterion score, and 1/0's for pass/fail for each item. Non-applicable information will be written zero.

The format for card output is:

(A6, 2X, A6, 2X, I3, 2X, 2F8.2, 2X, 41I1/80I1/79I1)

The Format for tape output is:

(2A6, I3, 2F7.2, 200I1)

III. Control Cards

Card 1 - Input Parameters

Card Column	Format	Source Listing Symbol	Description
1-3	I3	NSTITM	Number of test items; may not exceed 200 items.
4	I1	IUPLIM	Highest response choice (not including multiple-response answers) may not exceed 9. The response choices have to be consecutive positive integers, the largest of which is IUPLIM.
5	I1	NFM	Number of format cards for input data. Default when blank, NFM = 1.
6-7	I2	K1	FORTRAN logical unit number for data input (may be card reader or tape unit). ALL FORTRAN unit numbers should be greater than 9 on the UNIVAC 1100/81.
8-9	I2	KO	FORTRAN logical unit number for tape output, if applicable. May be left blank.
10-11	I2	KS	FORTRAN logical unit number for scratch tape (serves as working storage for program).

12-13	I2	NB	Number of bits in a word on the computer, not counting the sign bit. (NB is used in the word-packing routine.) If blank, NB will be set to 35.
14-15	F2.2	EASY	Specified difficulty level for identifying too-easy items, in percent (two digits with no decimal point).[1]
16-17	F2.2	DIFFLT	Specified difficulty level for identifying too-difficult items, in percent (two digits with no decimal point). NOTE: Default when both EASY and DIFFLT are blank; EASY = .8 and DIFFLT = .2.
18	I1	IALPHA	0 if all items are single-response (numeric). 1 if one or more items are multiple-response (alphanumeric).
19	I1	NSPEED	0 if a power test. 1 if a speed test.

[1] This option and the next one (DIFFLT) prints out items whose difficulty is outside of the specified difficulty-range.

20	I1	ICORGS	0 if scores are not to be corrected for guessing. 1 if scores are to be corrected for guessing by either standard formula or Hamilton's (1950) formula (see column 45). If corrected scores are called for, they will be used in all item analysis, unless an external criterion is used.
21	I1	KIV	0 if negative corrected scores are not to be set to zero. 1 if negative corrected scores are to be set to zero.
22	I1	ICRIT	0 if test score is to be used as the criterion. 1 if an external criterion is to be used (in this case, all item analyses will be based on this criterion.)
23-25	F3.0	OUT	Code for missing criterion score, in the case of an external criterion. Must be an integer value (no decimal point). Cases with missing criterion score will be excluded from the analysis and printed out.
26	I1	NOCASE	0 if case scores are to be printed. 1 if printing of case scores is to be suppressed.

27	I1	IPHI	0 if no phi correlation coefficient is desired. 1 if phi based on median score for the sample is desired. 2 if phi based on median is desired. (In case of a speed test, the mean will be computed based upon only those individuals who reached the particular item.)
28	I1	IFREQ	0 if no frequency distribution of scores is desired. 1 if frequency distribution is to be done with external criterion score (if applicable). 2 if frequency distribution is to be done with corrected test scores (if applicable). 3 if frequency distribution is to be done with raw test scores. NOTE: If phi with median is called for, the frequency distribution will be done accordingly, regardless of user's specification, since the median is calculated from the frequency distribution. For example, if phi with median is desired, and an external criterion is being used, IFREQ will be set to 1 automatically.

29	I1	IOVER	0 if Henrysson's (1963) method for overlap correction of item analysis with internal criterion is to be used. 1 if Guilford's (1953, 1965) method is to be used. 2 if no overlap correction is desired. NOTE: If overlap correction is called for, both the uncorrected and the corrected values will be printed.
30	I1	JPLOT	0 if only the proportion of individuals passing each item at various z-score (standard score) levels is to be printed. (No plot .) 1 if the (fitted) item characteristic curves are to be plotted. NOTE: On a speed test, proportions will be based on only on those individuals who reached the particular item.
31-32	I2	NF	Number of factors to be extracted from tetrachoric inter-item correlation matrix. If NF is specified as zero, the inter-item correlation matrix will not be computed. Otherwise, NF must lie in the range: $2 \leq NF \leq 10$.

33-35	F3.2	EIGN	Eigenvalue to serve as stop criterion for factor analysis of tetrachoric correlation matrix, if applicable. If an eigenvalue falls below this value, no further factors are extracted. This value is put on the card as three digits, the last two of which are considered to be after the decimal point. For example, if an eigenvalue cutoff of 1.00 is desired, it should be specified on the card as 100. An eigenvalue of 1.00 is commonly used.
36	I1	IDEND	0 if identification variable (ID) precedes responses in input data. 1 if ID follows responses.
37	I1	IRWIND	0 if input data tape is to be rewound before processing test; 1 otherwise. If only one test is being processed, this option is irrevlevant. If the same cases are to be used as were used in the previous test, IRWIND should be specified as 0, and the input format should pick up the fields on the tape that correspond to the present test.

38	I1	IOUT	0 if no tape or card output is requested. 1 if tape output is requested. 2 if card output is requested. The output will consist of a test ID, the case ID, score, corrected score, external criterion score, and 1/0's for pass/fail for each item. Any non-applicable information (such as the external criterion score for an internal criterion test run) will be written zero.
39-42	A4	ATEST	Test ID for tape or card output, if applicable.
43	I1	IALT	0 if scores are not to be corrected for guessing; or, if each item has the same number of response choices, and this number is equal to IUPLM as specified in Col. 4. 1 only if correction for guessing is called for; and, in addition, at least one item does not have the number of response choices equal to IUPLM; if this is the case, additional card(s) will be necessary (card no. 6).
44	I1	ICARD	0 if input data are on tape. 1 if input data are on cards.

45	I1	IHAM	1 of scores are to be corrected with Hamilton's (1950) formula; 0, otherwise. IALT must be 0; ICORGS must be 1.
46-48	I3	NERR	Maximum number of permissible input data errors specified by user (i.e. data do not match format editing code type; like reading alphanumeric with an I format.) If the number of errors equals or exceeds this number, the program will terminate. The case number and ID of each case with this type error will be printed. (See KERR Col. 58).
49-52	I4	NBIK	Blocksize if the input data file on unit KI is COBOL (max blocksize = 1203).
53-55	I3	LRL	Logical record length if data file on unit KI is COBOL. Both this field and the preceding one must be non-zero if the file is in COBOL (max LRL = 250).
56-57	I2	KS2	Unit ID for temporary file needed when 'Item Alternative Information Roster' is requested (0 or blank indicates the above roster is not requested). This file need not be assigned because the system will assign a temporary file of sufficient size.

58	I1	KERR	Data read error switch; 0 = system (FORTRAN) error exit routine, 1 = program error exit routine (see also NERR, Col. 46-48). NOTE: The system error exit will translate the error input character(s) into zeroes and print the system error message. The case is retained. The IAP program error exit will print the error case (see NERR) and reject the case.

Card 2 - Title Card

Any title less than or equal to 72 characters, starting in Col 1.

Card 3 - Input Data Format Card(s)

The ID will be read in "A" format with a field width of not more than six characters.

Responses to items with numeric answers will be read in "I" format.

Responses to items with alphanumeric answers (multiple-response items), if any, will be read in "A" format.

Skipped fields are indicated by "X". The format should begin with a left parenthesis and end with a right parenthesis. If more that one card is necessary, simply continue the format on additional cards. The number of format cards is specified on Card 1, Col 5. Each card of the format is read through Col 72 only.

As mentioned above under "Data Specification," the ID must be either the first or the last word read, and the external criterion (if any) must always precede the responses. The external criterion will be read in "F" format.

If a case requires more than one record (e.g., more than one card), a slash (/) in the format will cause the next record to be read.

Examples:

1.

```
(  5X  ,  A6  ,  30X  ,  20I1  ,  X  ,  A1  )
   ↑      ↑      ↑       ↑       ↑     ↑
   5             30      20      1     1
 Skipped  ID    Skipped  Numeric Skipped Alpha
```

2.

```
(  I1  ,  X  ,  3I1  ,  4A1  ,  50X  ,  3I1  /  20I1  ,  A6  )
   ↑      ↑     ↑       ↑       ↑       ↑     ↑   ↑      ↑
   1      1     3       4       50      3         20     ID
 Numeric Skip Numeric  Alpha   Skip    Numeric | Numeric
                                       Skip to next Record
```

3.

```
(X  ,  A6  ,  3X,  F6.2,  5X,  I1,  X,  20I1)
↑      ↑      ↑     ↑      ↑     ↑       ↑
1             3     Ext.   5     1       20
Skip   ID     Skip  Criterion Skip Numeric Skip Numeric
```

4.

(X,	F7.1,	I1,	2X,	3A1,	X,	70I1,	etc.,	X,	I1,		Card 1
2X,	3A1,	X,	5I1)						Col 70		Card 2

Here, two format cards are required to read one record since the format required more than 72 columns. In Example 2, one format card was needed to read two records.

Card(s) 4 - Answer Key for Numeric Items

The first three columns of the card(s) are not read, so anything may be written there (such as "KEY").

Starting in Col. 4, each column corresponds to an item specified in the "Format" statement, excluding the ID and the external criterion. For numeric items, the correct answer should be specified in the corresponding column. For alphanumeric (multiple-response) items, a "9" should be specified in the corresponding column. (A special key will be read in for alphanumeric items). Each "answer key" card contains keys for up to 77 items; 200 items will require three cards.

If desired, items can be omitted from analysis without changing the format. This is done by specifying a "0" in each of the columns corresponding to those items. The remaining items will be referred to in the output by the same numbers that they would be without any 0's in the key.

Examples:

KEY2341511357

This is a 10-item test in which all responses are numeric. The correct answer to item 1 is 2, and the correct answer to item 10 is 7.

KEY2341000057

This is a key for the same test as before, but items 5 through 8 are removed from the test by replacing the correct alternative with zero. The remaining items will be referred to as before, so items 1, 2, 3, 4, 9, and 10 are listed in the output.

Note that the same thing could have been accomplished by changing the format to "X" out items 5 through 8, and having the key changed to KEY234157. However, the items would now be referred to as items 1, 2, 3, 4, 5, and 6.

KEY1235499221

Here, items 6 and 7 are alphanumeric (multiple-response), and the correct answers to these items will be read in on the next card.

Card(s) 5 - Answer Key for Alphanumeric Items

This card is optional and is included only if "ALPHA" was specified as 1 (Card 1, Col 18).

There are 33 possible multi-response codes. In order that each response occupy only one character in the data file, these responses are coded alphanumerically, using the numbers 1 through 9 and all letters of the alphabet except W and Y. These characters are converted to integers by a method that is machine-dependent; on machines other than the Univac 1100/81 a few changes will probably be necessary.

The codes for each alphanumeric character are as follows:

Alphanumeric Character (Response)	Code
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

Alphanumeric Character (Response)	Code
A	10
B	11
C	12
D	13
E	14
F	15
G	16
H	17
I	18
J	19
K	20
L	21
M	22

Alphanumeric Character (Response)	Code
N	23
O	24
P	25
Q	26
R	27
S	28
T	29
U	30
V	31
X	32
Z	33

Any other response will be considered as an omit.

Correction for guessing is not made on alphanumeric items. The character "W" is reserved for indicating the item after the last item attempted by a subject on a speed test with alphanumeric responses.

The card(s) are prepared as follows: Each response-item combination will occupy six card columns. The first three columns will contain the item number; the next two columns will contain the code for the response as given above; and the last column will contain the number of points credit to be given that response. Any response not listed will receive no credit. Up to 13 responses may be listed per card (Cols 1-78). If more than 13 item-response combinations are necessary, continue the same procedure on subsequent cards. Each item-response combination listed must immediately follow the preceding. The six columns following the last combination must contain 999999. If a frequency distribution of scores is to be made, the maximum total score must not exceed 1000.

Example:

Suppose that items 3 and 5 have alphanumeric responses, and that each one has two possible responses that are to receive credit--a "2" to receive 1 point, and a "B" (code "11") to receive 2 points. The card would appear:

003021	003112	005021	005112	999999
Item Number Response Code Credit	Item Number Response Code Credit	Item Number Response Code Credit	Item Number Response Code Credit	6 nines

Card(s) 6 - Alternate Response Cards

This card is optional and is included only if "IALT" (Col 43 of Card 1) was "1".

The purpose of the card is to indicate the number of choices for each item (if any different from "IUPLIM" in Col 4 of Card 1) so that the proper correction for guessing can be made.

The first three columns are not read and may contain anything (such as "ALT"). Starting in Col 4, each column contains the number of alternate response choices for the corresponding item. If there are more than 77 items, continue on a second card (skipping the first three columns again). If an item is alphanumeric, its corresponding column may be left blank, or may contain any integer, since it is not used.

Example:

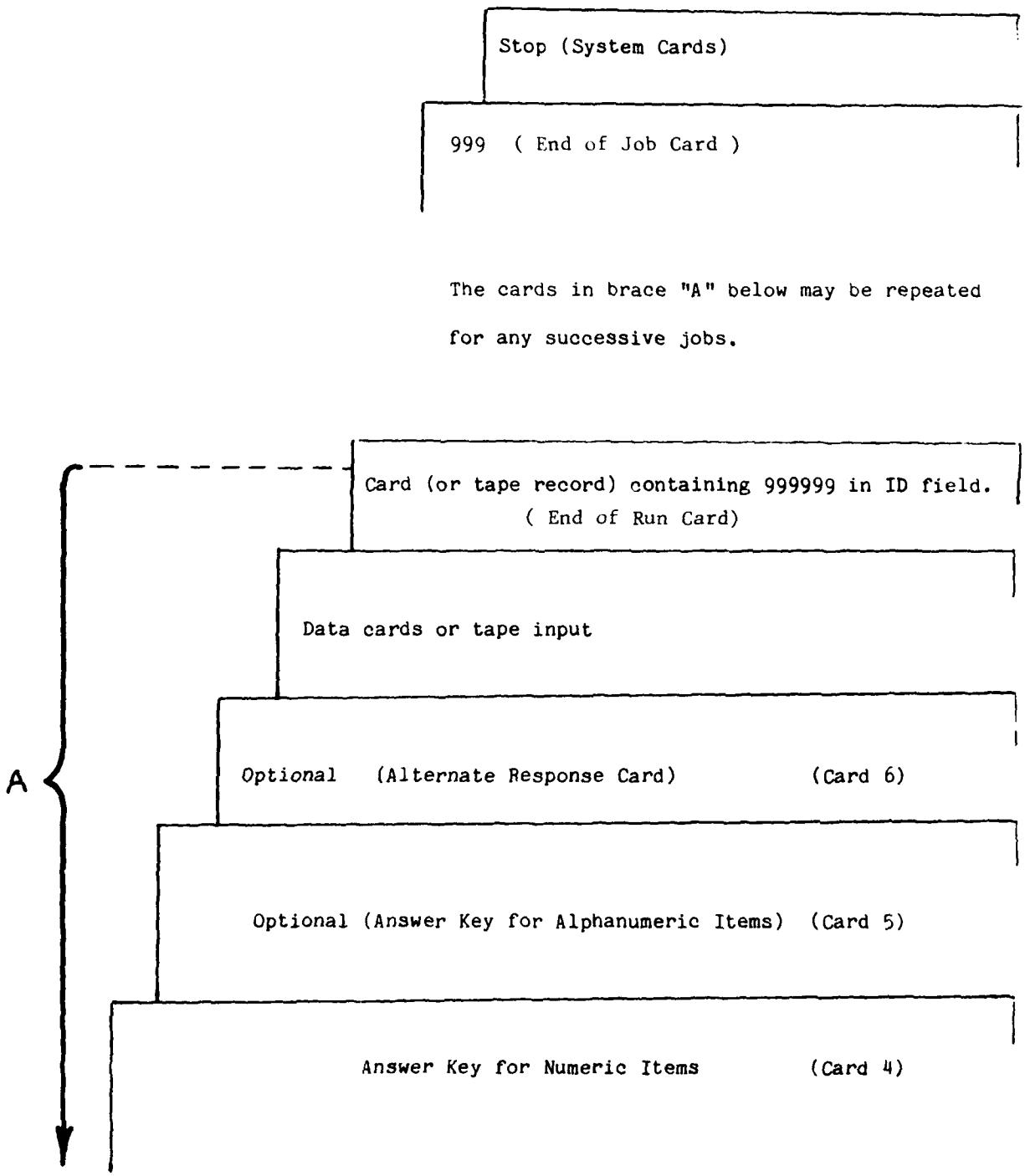
ALT444555333

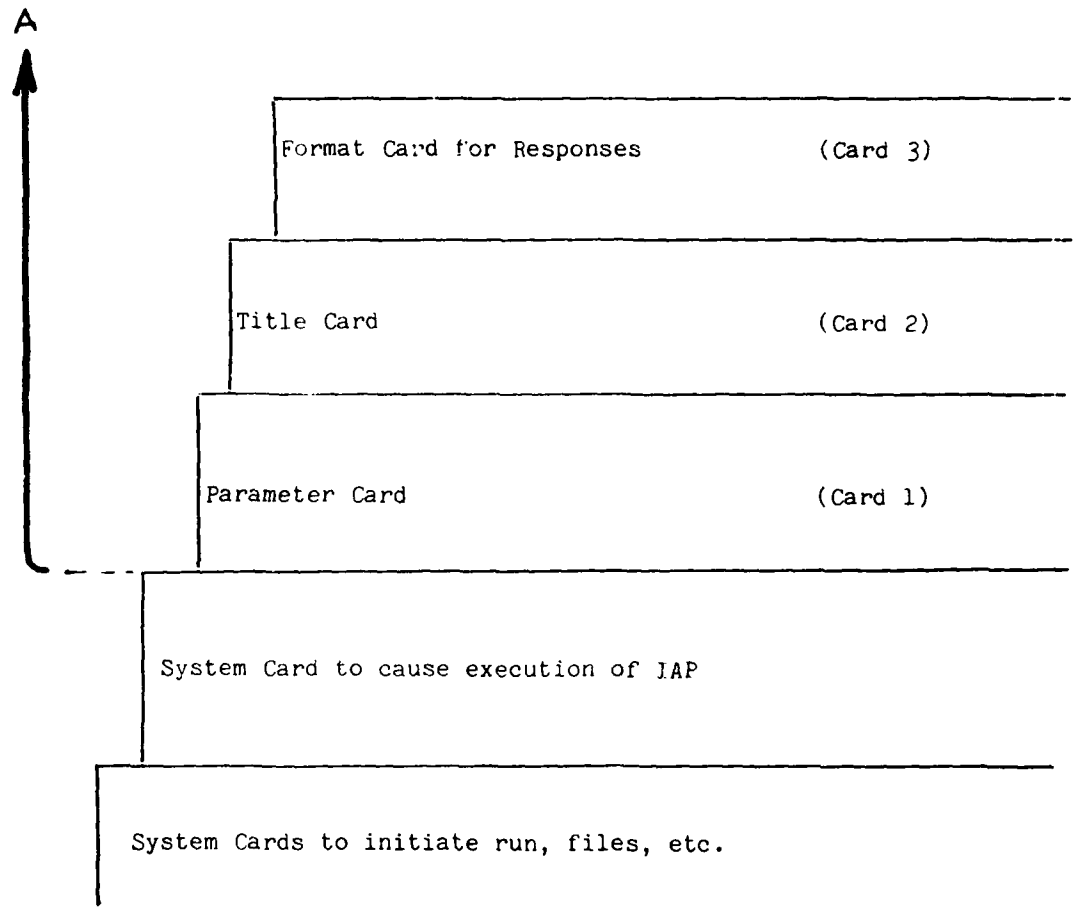
Here, there were nine items. The first three items had four alternatives; items 4 through 6 had five alternatives; and items 7 through 9 had three alternatives.

Note:

Following the last control card for the last job there must be a card containing "999" in Cols 1-3.

Card - Input Sequence (in reverse order).





NOTE: The term "card" refers to the type of card(s). There may be more than one physical card per card type. (See detailed description of card preparations.)

IV. SUMMARY

This report describes the development and implementation of a state-of-the-art computer-based item analysis technique. It deviates from traditional techniques by providing detailed information about the characteristics of achievement test items, particularly the ability level at which a given item discriminates most and the degree of discrimination. Here discrimination is independent of item difficulty, unlike traditional methods where the discrimination index is a function of the difficulty. This paper includes all information necessary for potential users and provides all formulas and mathematical derivations upon which the algorithm is based. The computer program has been written in FORTRAN V on the UNIVAC 1100/81 computer system and is easily convertible to other systems. An exception is the plotting subroutine for the item characteristic curves. This subroutine is written in COBOL and is machine-specific. However, the program can be used without the plot-routine since one of the options provides all numerical information about the item characteristic curves and permits manual graphing with ease.

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APPENDIX A

COMPUTATIONAL FORMULAS AND MATHEMATICAL DERIVATIONS

1. Raw Score - number of correctly answered items.

2. Correction for Guessing Formulas.

a. Standard correction (Guilford, 1965, p. 489.)

$$\text{Corrected Score} = (\text{number correct}) - \sum_{i=1}^{n} \frac{1}{(K_i - 1)}$$

Where K_i = the number of choices for item i,

n = number of items included in the item analysis,

and the sum is taken over those items to which a wrong response was given.

If $K_i = K$ for all i, then this reduces to

$$(\text{number correct}) - \frac{\text{number wrong}}{K - 1}$$

For items with more than a single correct answer (multiple-response), no correction for guessing is made.

b. Hamilton Correction (Hamilton, 1950)

Corrected Score = a+(b)·(raw score)

where a and b are the coefficients of the linear regression of the corrected score on the raw score.

$$a = \frac{\bar{R}\bar{W} - n\sigma_r^2}{(k-1)\sigma_r^2} \qquad \text{and} \qquad b = \frac{k\sigma_r^2 - \bar{W}}{(k-1)\sigma_r^2}$$

where: $\bar{R}$ = mean number of questions answered correctly

$\bar{W}$ = mean number of incorrect answers

n = number of items in the test

k = number of alternatives per item

σ_r^2 = variance of the raw scores

The squared correlation coefficient between the corrected scores and raw scores is:

$$r^2 = \frac{k\sigma_r^2 - n + \bar{R}}{k\sigma_r^2}$$

NOTE: For multiple-response items (more than one correct answer), no correction for guessing is made.

3. Mean = $\bar{X} = \sum_{i=1}^{N} \frac{X_i}{N}$ where N = the number of scores being considered.

4. Variance = $\sigma^2 = \frac{\sum_{i=1}^{N} X_i^2 - (\sum_{i=1}^{N} X_i)^2/N}{N-1}$

5. Standard Deviation = $\sigma = \sqrt{\sigma^2}$

6. Standard Error of the Mean = $\frac{\sigma}{\sqrt{N}}$

7. Skewness = $\frac{N}{(N-2)\quad(N-1)} \cdot \frac{S3}{\sigma^3}$

where $S3 = \sum X^3 - 3(\sum X/N)\sum X^2 + 2(\sum X/N)^2 \sum X$

8. Kurtosis = $Q4/\ ^4$

where $Q4 = \frac{N}{(N-1)\quad(N-2)\quad(N-3)} \left[(N+1)\quad(\sum X^4 - 4(\sum X/N)\sum X^3 + \right.$

$\left. 6(\sum X/N)^2 \sum X^2 - 3(\sum X/N)^3 \sum X) - 3((N-1)/N)) \cdot (\sum X^2 - \frac{(\sum X)^2}{N}) \right]$

9. Standard Error of the Standard Deviation = $\sqrt{\frac{\sigma^2}{N} \cdot (.5 + .25Q4/\sigma^4)}$

10. Standard error of Skewness = $\sqrt{\frac{6N(N-1)}{(N-2)(N+1)(N+3)}}$

11. Standard Error of Kurtosis = $\sqrt{\frac{24N(N-1)^2}{(N-3)(N-2)(N+3)(N+5)}}$

12. z-score = $\frac{X - \bar{X}}{\sigma}$

13. T score = (z score) . (10) + 50

14. Item Standard Deviation = $\sqrt{pq}$

where p = the proportion of examinees answering the item correctly.

q = the proportion of examinees answering the item incorrectly,

where, necessarily $q = 1 - p$.

15. Point Biserial Correlation (between item and total test score).

$$r_{pbis} = \frac{M_p - M_q}{\sigma}\sqrt{pq}$$

where M_p is the mean test score for persons answering the item correctly, M_q is the mean test score for persons answering the item incorrectly.

16. Biserial correlation.

$$r_{bis} = \frac{M_p - M_q}{\sigma} \cdot \frac{pq}{y}$$

where y is the ordinate at the point of dichotomy in a standard normal distribution (see 25, below).

17. t-test to test the significance of the correlation coefficient.

$$t = \frac{r\sqrt{N-2}}{\sqrt{1-r^2}}$$

where r is the correlation coefficient and the resulting t has (N - 2) degrees of freedom.

18. $X50 = \frac{X}{r_{bis}}$

where X = the abcissa value at the point of dichotomy in a standard normal distribution (see 25 below).

X50 specifies the z-score on the (fitted) item characteristic curve at which 50% of the persons having the z-score chose the correct response. The item characteristic curve is a cumulative normal ogive fitted to the distribution of z-scores versus the proportion passing the item at each z-score level.

19. $\beta = \dfrac{r_{bis}}{\sqrt{1 - r_{bis}^2}}$ measure of the discrimination power of the item.

In non-technical terms β may be thought of as the slope of the item characteristic curve at X50. Mathematically it is the inverse of the standard deviation of the normal (fitted) ogive.

20. Reliability index of the item.

$RI = \left(r_{pbis}\right) \cdot \sqrt{pq}$ = the contribution of the item variance to the total test variance (Gulliksen, 1950, pp. 375-378).

21. Kuder Richardson Formula 20 (test reliability).

$$r = \frac{n}{n-1} \cdot \frac{s_x^2 - \sum_{i=1}^{n} p_i q_i}{s_x^2}$$

where n = number of test items.

s_X^2 = variance of scores on test,

p_i = proportion of examinees passing item i (difficulty of item),

q_i = proportion of examinees failing item i where $q_i = 1 - p_i$

22. Phi Coefficient $= \dfrac{BC - AD}{\sqrt{(A + B)(C + D)(A + C)(B + D)}}$

where the terms of the equation are defined as follows :

Test Scores

	Lower 50%	Upper 50%	
Pass	A	B	A + B
Fail	C	D	C + D
	A + C	B + D	

23. Computing the Tetrachoric Correlation

The tetrachoric correlation is an estimation of the correlation between two variables that are assumed to be from a bivariate normal distribution (i.e., marginal distributions normal, and linearity of regression) when the only actual information given about the distribution is dichotomous (i.e., four-fold frequency table, where the lines of dichotomy are necessarily the medians).

To be more specific, the procedure is:

(1) Determine, for each variable, what the point of dichotomy should be in a standard normal distribution to produce the observed proportions above and below the dichotomy for that variable. This is simply the inverse function for the normal distribution, whose computation is described above.

(2) Determine what correlation in a bivariate normal distribution will give the observed proportions in the four regions described by the four-fold table. This involves two problems:

a. The bivariate normal distribution must be represented as a function of r, the correlation, and equated to the observed proportion in a given region.

b. This equation must be solved for r. An iteration scheme must be used, since the bivariate normal distribution is an integral that must be computed numerically or written in a series expansion; if written as a series expansion, a polynomial equation of high degree must be solved, which requires iteration.

The usual approach is to use the series expansion and solve by iteration. However, for even a moderately large r, the series coverges very slowly; and for each iteration, it must be recomputed.

What is needed then is:

(1) A better method for computing the bivariate normal distribution.

(2) A scheme requiring the fewest possible iterations, since the slowest part of the computation is the bivariate normal.

The method used for computing the bivariate was based on the T-function of Owen (1956, p. 1075). The error in the program is less than $5X10^{-8}$ for all correlations and upper limits.

The equation was solved in a manner similar to Newton's (Acton, 1970) method, but with higher order terms included. This was done because the higher order derivatives can be obtained very simply, and are much cheaper than further iterations. (It was found that, using the Cosine-Pi formula of Pearson as a starting approximation, usually only one iteration was necessary to produce the maximum available accuracy, and at most two.)

The series was developed as follows:

$$\text{Let} \quad B(h,k,r) = \frac{1}{2\pi\sqrt{1-r^2}} \int_{-\infty}^{h}\int_{-\infty}^{k} e^{-\frac{1}{2}\left(\frac{x^2+y^2-2yxr}{1-r^2}\right)} dx\,dy$$

If B is ditterentiated with respect to r, then the double integration can be pertormed, leaving

$$\frac{dB}{dr} = \frac{1}{2\pi\sqrt{1-r^2}}\, e^{-\frac{1}{2}\left(\frac{h^2+k^2-2hkr}{1-r^2}\right)}$$

Therefore:

$$\frac{dr}{dB} = 2\pi(1-r^2)^{\frac{1}{2}}\, e^{+\frac{1}{2}\left(\frac{h^2+k^2-2khr}{1-r^2}\right)}$$

Let

$$z(r) = 2\pi\, e^{+\frac{1}{2}\left(\frac{h^2+k^2-2hkr}{1-r^2}\right)}$$

Then

$\frac{dr}{dB}$ can be rewritten as tollows:

$$\frac{dr}{dB} = z(r)(1-r^2)^{\frac{1}{2}}$$

Furthermore

$$\frac{d^2r}{dB^2} = \left[\frac{d}{dr}\left(\frac{dr}{dB}\right)\right]\frac{dr}{dB} = \left[-r(1-r^2)^{-\frac{1}{2}}z(r) + (1-r^2)^{\frac{1}{2}}\frac{dz}{dr}\right]\frac{dr}{dB}$$

$$= z^2(r)\left[(h^2+k^2-2hkr)(r)(1-r^2)^{-1} - hk - r\right]$$

$$\frac{d^3r}{dB^3} = \left[\frac{d}{dr}\left(\frac{d^2r}{dB^2}\right)\right]\frac{dr}{dB} =$$

$$\frac{dr}{dB}\left\{2z\ \frac{dz}{dr}\left[(h^2+k^2-2khr)(r)(1-r^2)^{-1}-hk-r\right]\right.$$

$$+z^2\left[(h^2+k^2-2hkr)(1-r^2)^{-1}\right.$$

$$\left.\left.-2hkr(1-r^2)^{-1}+2r^2(1-r^2)^{-2}(h^2+k^2-2hkr)-1\right]\right\}$$

$$=z^3(r)\left[\left\{\left[\left\{(h^2+k^2-2hkr)(r)(1-r^2)^{-1}\right\}\right.\right.\right.$$

$$\left\{(h^2+k^2-2hkr)(r)(1-r^2)^{-1}-2hk\right\}$$

$$\left.\left.+\tfrac{1}{2}(h^2+k^2-2hkr)+h^2k^2\right]\div\tfrac{1}{2}\sqrt{1-r^2}\right\}-\sqrt{1-r^2}\left.\right]$$

By assigning constants as follows, these three terms can be further simplified.

Let

$$C_0 = hk$$

$$C_1 = 1 - r^2$$

$$C_2 = \sqrt{C_1}$$

$$C_3 = 2C_0$$

$$C_4 = h^2 + k^2 - C_3 r$$

$$C_5 = C_4 / C_1$$

$$C_6 = rC_5$$

$$Z = (2\pi i) \exp\left(\tfrac{1}{2} C_5\right)$$

$$D_2 = C_6 - C_0 - r$$

$$D_3 = 2\left[C_6 (C_6 - C_3) + \tfrac{1}{2} C_4 + C_0^2\right] / C_2 - C_2$$

Then:

$$\frac{dr}{dB} = C_2 Z$$

$$\frac{d^2 r}{dB^2} = D_2 Z^2$$

$$\frac{d^3 r}{dB^3} = D_3 Z^3$$

No attempt was made to develop higher order terms, because three seemed to give maximum accuracy with only one iteration in most cases; higher terms could be generated in a straightforward manner, with considerable labor.

A first approximation is made with Pearson's Cosine-Pi formula. With this r, the proportion in any one of the four regions is computed using the scheme mentioned above. The difference between this proportion and the desired one in the region is computed, called, say, ΔB.

Let $X = Z(\Delta B)$. Then r is corrected as follows:

$$r_{\text{corrected}} = r + X \left[C_2 + x \left(1/2 D_2 + 1/6 D_3 x\right)\right]$$

If one iteration does not produce agreement to within 5×10^{-8} in the proportion, another iteration is performed. In this way, the desired correlation is reached.

The accuracy obtained in the correlation itself varies. For certain distributions (correlations very nearly 1.0, or very large or small h and k), dB/dr is nearly zero, so that a small error in the proportion corresponds to a large error in the correlation. However, the correlation given by the program does reproduce the four-fold table with an error of not more than 5×10^{-8}, which is a reasonable measure of the accuracy of the correlation. It should also be noted that in the exceptional ranges mentioned, a small error in the input causes a very large error in the correlation, making it highly unreliable. (These are the cases where the standard error is largest, for a given N.)

24. If there is an outside criterion, a validity coefficient is computed which is Pearson's r.

$$r_{xy} = \sum_{i=1}^{N} \frac{(x_i - \bar{x})(y_i - \bar{y})}{N \sigma_x \sigma_y}$$

where r_{xy} = correlation between X and Y.

X_i = internal criterion scores.

$\bar{X}$ = mean of X values.

Y_i = external criterion scores.

$\bar{Y}$ = mean of Y values.

σ_X = standard deviation of the distribution of X scores.

σ_Y = standard deviation of the distribution of Y scores.

25. Calculation of abcissa and ordinate of standard normal distribution at dichotomy.

The abcissa (X) and the proportion passing item (p) are related as follows:

$$p = \frac{1}{\sqrt{2\pi}} \int_{x}^{\infty} e^{-\frac{1}{2}u^2} du$$

The ordinate (y) is then computed as:

$$y = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2}$$

x is obtained in the manner discribed in 26 below.

26. Computation of the Inverse Normal Distribution Function.

The inverse normal (cumulative) distribution function x(q) is defined by the equation

$$q = \frac{1}{\sqrt{2\pi}} \int_{x(q)}^{\infty} e^{-\frac{1}{2}t^2} dt \quad , \qquad 0 < q < 1$$

However, since $x(1 - q) = -x(q)$, only the $0 < q \leq .5$ range is necessary to be considered.

Hastings (1964) gives a min-max rational approximation to x(q) which has a maximum error of 4.5×10^{-4} over the range $0 < q \leq .5$. Since greater accuracy was desired, the following approach was taken.

(a.) Obtain the derivatives of x(q) as follows:

$$q = \frac{1}{\sqrt{2\pi}} \int_{x(q)}^{\infty} e^{-\frac{1}{2}t^2} dt$$

$$\frac{dq}{dx} = -\frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2} \quad \text{and} \quad \frac{dx}{dq} = -\sqrt{2\pi}\, e^{\frac{1}{2}x^2}$$

$$\frac{d^2x}{dq^2} = \left[\frac{d}{dx}\left(\frac{dx}{dq}\right)\right]\frac{dx}{dq} = \left(\frac{dx}{dq}\right)^2 x$$

$$\frac{d^3x}{dq^3} = \left[\frac{d}{dx}\left(\frac{d^2x}{dq^2}\right)\right]\frac{dx}{dq} = \left(\frac{dx}{dq}\right)^3 (1 + 2x^2)$$

$$\frac{d^4x}{dq^4} = \left[\frac{d}{dx}\left(\frac{d^3x}{dq^3}\right)\right]\frac{dx}{dq} = \left(\frac{dx}{dq}\right)^4 (7x + 6x^3)$$

$$\frac{d^5x}{dq^5} = \left[\frac{d}{dx}\left(\frac{d^4x}{dq^4}\right)\right]\frac{dx}{dq} = \left(\frac{dx}{dq}\right)^5 (7 + 46x^2 + 24x^4)$$

Higher order terms are generated in a similar manner.

(b.) Obtain an initial approximation of x_1 by the Hastings formula (26.2.23).

(c.) Compute the error in q(x), say $\Delta q = q(x_i) - q$. Most Fortran compilers have the Error Function available from which $q(x_i)$ can be obtained. For large x_i, a Gaussian continued fraction can be used to arrive at Δq.

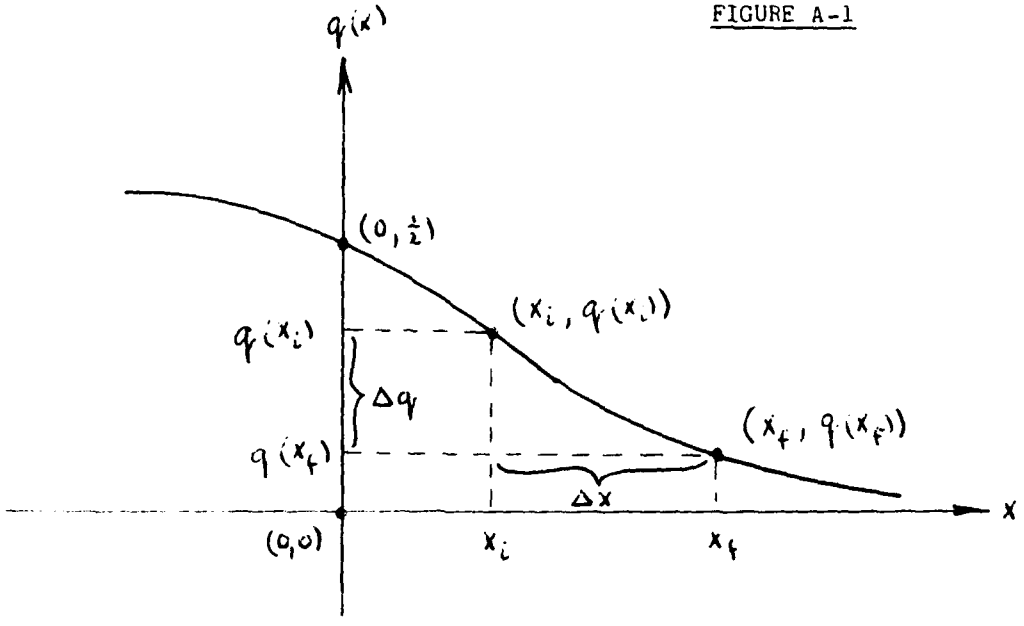
(d.) Write the correction terms as a Taylor series for x in terms of Δq, expanding about $q(x_i)$ (which is the q of the initial approximation), $10^{-38} \; q \; \_\_ \; .5$. The lower limit ($10^{-38}$) is the smallest number on the IBM 7040 computer on which this program was developed.

It was found that only the first two terms of the Taylor series were required to attain desirable precision on an eight-digit machine, yielding an error of the magnitude of 5×10^{-8}. Using the first five terms of the series resulted in an error of less than 10^{-15}.

The first term in the series is equivalent to a single iteration by Newton's method. The reason for using higher order correction terms in lieu of further interations is that the former can be obtained very quickly from the first-order term, whereas additional iterations would require evaluation of q(x) and dx/dq for each iteration.

A graphical illustration may be helpful to understand the algorithm. Figure A-1 shows the initial approximation x_i, with the associated $q(x_i)$; the derived $q(x_F)$ associated with the final approximation x_f, and the error (or difference) between the initial and final approximation (Δx and Δq).

FIGURE A-1



$$\Delta x = \frac{dx}{dq}(\Delta q) + \frac{1}{2}\frac{d^2x}{dq^2}(\Delta q)^2 + \ldots$$

The final approximation, x_F, correct to eight digits can be written as follows:

Let

$$z = \frac{dx}{dq}(\Delta q) = -\sqrt{2\pi}\, e^{\frac{1}{2}x^2}(\Delta q)$$

Then

$$x_f = x + z\left(1 + \frac{1}{2}xz\right)$$

For 16-digit accuracy the final approximation, x_F, takes the form of:

$$X_F = x + Z\left(1 + Z\left(\frac{x}{2} + Z\left((1 + 2x^2)/6 + Z\left(x(7+6x^2)/24 + Z\,(7 + x^2(46 + 24x^2))\,/120\right)\right)\right)\right)$$

27. Correction for overlap in biserial correlation when item score contributes to criterion score (internal criterion).

Guilford's Method:

$$\text{corrected } r_{bis} = \frac{r_{h.s}\,\sigma - pq/y}{\sqrt{\sigma^2 + (pq/y)^2 - 2r_{h.s}\,\sigma\,(pq/y)}}$$

where σ = standard deviation of test.

p,q are the same as in 14.

Henrysson's Method:

$$\text{corrected } r_{bis} = \frac{r_{bis}\,\sigma - pq/y}{\sqrt{\sigma^2 + pq - 2r_{bis}\,\sigma y}}$$

28. Correction for overlap in point biserial correlation.

$$\text{corrected } r_{pbis} = \frac{r_{pbis}\,\sigma - \sqrt{pq}}{\sqrt{\sigma^2 + pq - 2r_{pbis}\,\sigma\sqrt{pq}}}$$

29. More on the Item Characteristic Curve

The information given about the item variable is a dichotomy since the item score is either pass or fail. To justify the statements about the shape of the item characteristic curve (i.e., ogive) and the formulas used for estimating its parameters, we have to make certain basic assumptions:

(1) The item variable is continuous even though we know only dichotomous information about it. That is individuals know various amounts of information about the item, a certain amount of which is necessary to fall into the pass/fail dichotomy.

(2) The regression of the item variable on the criterion variable is linear.

(3) The conditional distribution of the item variable (i.e., the distribution of the item variable for a given criterion score) is normal, with a variance independent of the criterion

The following discussion assumes that both the criterion variable and the item variable are in standard scores (i.e., deviations from the mean in standard deviation units). This means that the regression line passes through the origin, has a slope of r, where r is the correlation between the two variables, and the variance of the conditional distribution of the item variable is $(1-r^2)$. Figure A-2 is a graphic representation of the situation where

p = proportion of individuals passing the item

q = (1 - p) = proportion of individuals failing the item

c = cutoff point on the item variable corresponding to the pass/fail dichotomy

The abscissa represents the criterion variable in standard scores (x-axis).

The ordinate represents the item variable in standard scores (y-axis). p(x) = proportion of individuals passing the item for a given criterion score x (shaded areas in Figure A-2).

Conditional Distributions

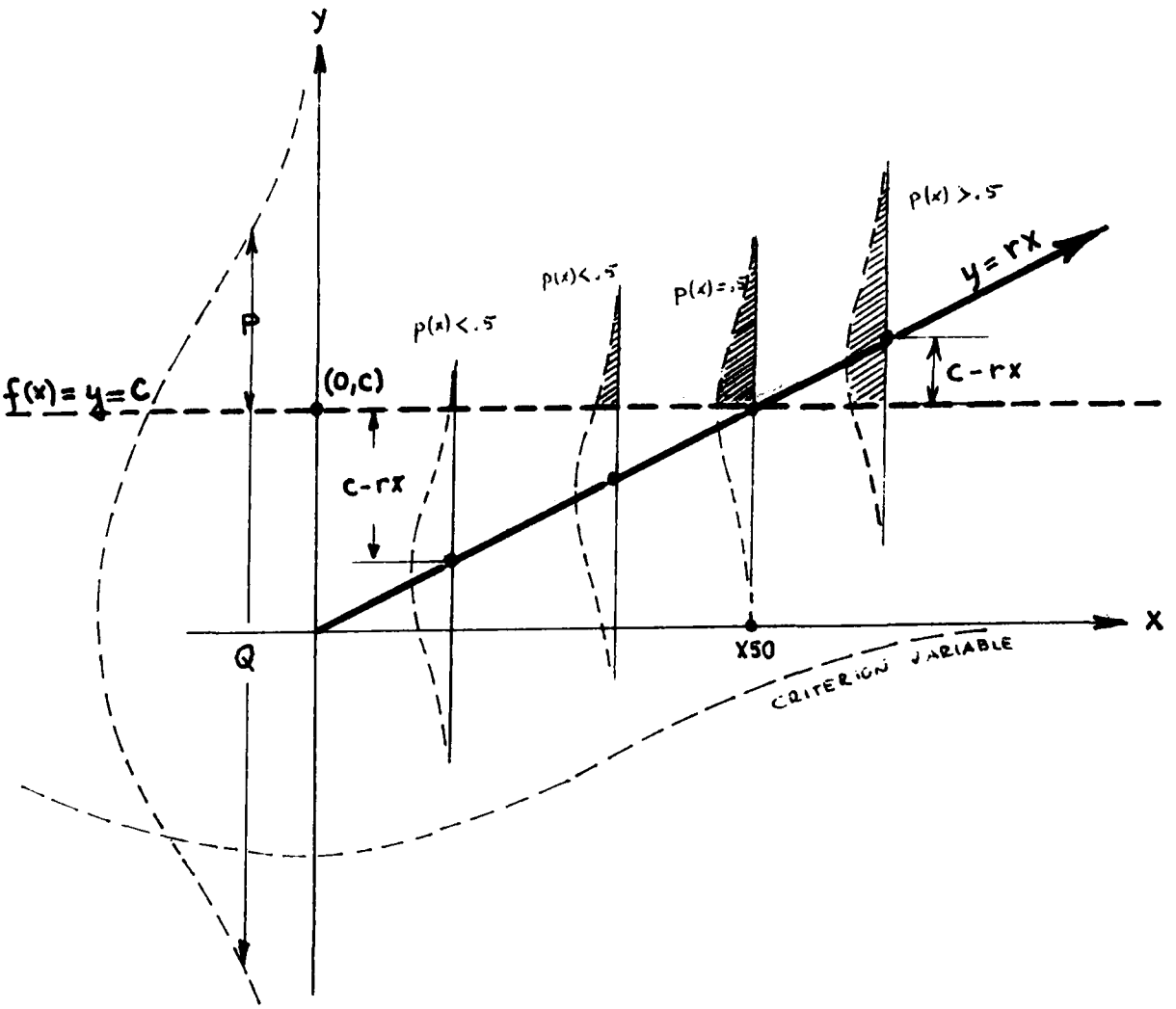


FIGURE A-2

The conditional distributions have means on the line y = rx since linearity of regression was assumed.

Consider now $p(x)$, the proportion above the cutoff point C in the conditional distribution varies with x. Since the conditional distribution is normal, its variance is $1 - r^2$ (see Proof 1) and furthermore this variance is independent from x. However, as x increases, the distance between the mean of the conditional distributions and the cutoff point C increases as well. In fact this distance is $(C - rx)$. Since the displacement of the mean from the cutoff is a linear function of x, the proportion above the cutoff in the conditional distribution produces a normal ogive (cumulative normal distribution) with respect to x.

Proof 1 To prove that the variance of the conditional normal distribution equals $(1 - r^2)$.

By hypothesis, the variance of the conditional distribution is constant, say σ^2. Also by hypothesis, the mean of the conditional distribution is (rx). Therefore

$$(1) \qquad \int_{-\infty}^{\infty} (y - rx)^2 f(y \mid x)dy = \sigma^2$$

where $f(y|x)$ = conditional density of y

Also by hypothesis (normal distribution), the means of y and x are zero and their variance is 1.

Thus:

$$(2) \qquad \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} y^2 g(x) f(y|x)\,dy\,dx = 1 \qquad \text{Variance of } y$$

where $g(x)$ = density of x

and $g(x)f(y|x)$ = joint density of y and x

from (1) above

$$\int_{-\infty}^{\infty} y^2 f(y|x)\,dy - 2rx\int_{-\infty}^{\infty} y f(y|x)\,dy + r^2x^2\int_{-\infty}^{\infty} f(y|x)\,dy = \sigma^2$$

Collecting terms and realizing that

$$\int_{-\infty}^{\infty} y f(y|x)\,dy = rx, \quad \int_{-\infty}^{\infty} y^2 f(y|x)\,dy = 2r^2x^2 - r^2x^2 + \sigma^2 = \sigma^2 + r^2x^2$$

Substituting into (2) results in:

$$\int_{-\infty}^{\infty} g(x)\int_{-\infty}^{\infty} y^2 f(y|x)\,dy\,dx = \int_{-\infty}^{\infty} (\sigma^2 + r^2x^2) g(x)\,dx = \sigma^2\int_{-\infty}^{\infty} g(x)\,dx + r^2\int_{-\infty}^{\infty} x^2 g(x)\,dx = 1$$

Since

$$\int_{-\infty}^{\infty} g(x)\,dx = 1 \qquad \text{density of } x$$

and

$$\int_{-\infty}^{\infty} x^2 p(x)dx = 1 \qquad \text{variance of } x \text{ by hypothesis}$$

we have

$$r^2(1) + r^2(1) = 1$$

$$r^2 + r^2 = 1$$

$$r^2 = 1 - r^2$$

Returning to Figure A-2, at the point where the cutoff line $y + C$ intersects the regression line $y = rx$, the value of x is called X50. At this point as it can be seen from Figure A-2, 50% of the conditional distribution falls above and 50% falls below the cutoff since the mean of the conditional distribution coincides with the cutoff at this point. Since $C = r(X50)$ at this point, $X50 = C/r$.

X50 is also the inflection point for the item characteristic curve (the curve of p(x) plotted against the criterion score). This curve is a normal ogive and has a standard deviation of

$$\sigma = \frac{\sqrt{1 - r^2}}{r}$$

Proof 2 The conditional density of the item variable y is

$$P(y|x) = \frac{1}{\sqrt{2\pi}\sqrt{1-r^2}} e^{-\frac{1}{2}\frac{(y-rx)^2}{1-r^2}}$$

The proportion above the cutoff is

$$P(x) = \frac{1}{\sqrt{2\pi(1-r^2)}} \int_c^\infty e^{-\frac{1}{2}\frac{(y-rx)^2}{1-r^2}} dy$$

let $t = y/r - x$

$dy = rdt$

then

$$P(x) = \frac{r}{\sqrt{2\pi(1-r^2)}} \int_{\frac{c}{r}-x}^\infty e^{-\frac{1}{2}\frac{t^2}{(1-r^2)/r^2}} dt$$

which is a normal ogive with standard deviation of $\frac{\sqrt{1-r^2}}{r}$

and inflection point of c/r.

The reciprocal of the standard deviation of the normal ogive is called

β and $\beta = r/\sqrt{1-r^2}$

There are numerous methods of estimating the parameters c and r from a given sample. Probably the best is the maximum likelihood method by which c and $\hat{r}$, the estimates of c and r, are chosen in such a way as to maximize the probability of occurrence of the sample data at hand, with the hypothesized probability distribution depending only on these two parameters. However, this method leads to non-linear simultaneous equations which must be solved iteratively with considerable labor at each step. A far simpler method for estimating r is by use of the biserial correlation. This method, however, requires two additional assumptions, namely that the regression of the criterion variable on the item variable is normal. The formula can be arrived at as follows:

Let $f(x|y)$ be the conditional density x. The marginal distribution of y is hypothesized to be standard normal, so the density of y is

$$g(y) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}y^2}$$

The assumption of linearity of regression of x and y means that

$$\int_{-\infty}^{\infty} xf(x|y)dx = ry$$

that is, the mean of the conditional distribution of x falls on the line $x = ry$.

Now consider $\bar{X}_p$ = mean criterion value for cases above the cutoff line $y = c$.

$$\bar{X}_p = \frac{\int_c^{\infty}\int_{-\infty}^{\infty} xf(x|y)g(y)dxdy}{\int_c^{\infty}\int_{-\infty}^{\infty} f(x|y)g(y)dxdy}$$

where $f(x|y)g(y)$ is the joint density of x and y.

$$\bar{X}_p = \frac{\int_c^{\infty} g(y)\int_{-\infty}^{\infty} xf(x|y)dxdy}{\int_c^{\infty} g(y)\int_{-\infty}^{\infty} f(x|y)dxdy}$$

Now

$$\int_{-\infty}^{\infty} xf(x|y)dx = ry$$

by hypothesis and

$$\int_{-\infty}^{\infty} f(x|y)dx = 1$$

therefore $\bar{X}_p = \dfrac{r\int_c^{\infty} yg(y)dy}{\int_c^{\infty} g(y)dy}$

but

$$\int_c^\infty g(y)\,dy = P$$

thus

$$\bar{x}_p = \frac{r\int_c^\infty y\,\frac{1}{\sqrt{2\pi}}\,e^{-\frac{1}{2}y^2}\,dy}{P} = \frac{1}{\sqrt{2\pi}}\,\frac{r}{P}\,e^{-\frac{1}{2}c^2}$$

hence

$$r = \frac{P\,\bar{x}_p}{\frac{1}{\sqrt{2\pi}}\,e^{-\frac{1}{2}c^2}}$$

Let

$$Z = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}c^2}$$

where c is simply the abscissa corresponding to a proportion P in a standard normal distribution, since the item variable was assumed to be normally distributed.

Rewriting $\bar{X}p$ in terms of raw scores,

$$r = \frac{P}{Z} \cdot \bar{X}p = \frac{M_p - M_x}{\sigma_x} \cdot \frac{P}{Z}$$

which is the formula for the biserial correlation.

This relationship is exact for the population but it is only an estimate when written in terms of sample values. It is not as efficient as the maximum likelihood method, particularly for a large r; in fact for a large r, it is a rather poor estimator.

It is possible to incorporate the maximum likelihood method in this item analysis package; however, core limitations of the computer (IBM 7040) for which this program was originally developed would have made the attempt impractical with an added costly time factor. See also Ree (1979).

30. Average Item Difficulty

The percent of individuals passing a certain item is converted to a standard difficulty (D):

$$D = 0.5 - 0.16147653x$$

where x is the abscissa corresponding to the proportion of individuals passing the item (upper portion of the normal distribution).

To convert back from standard difficulty to the corresponding proportion:

$$\text{Proportion} = \frac{1}{\sqrt{2\pi}} \int_{x}^{\infty} e^{-\frac{1}{2}t^2} dt$$

where $x = (.5 - D)/.16147653$

Averaging is done with standard difficulties and then converted back to proportion passing.

A proportion of .999 converts to a D = .999

" " " .001 " " " D = .001

" " " .500 " " " D = .500

" " " $\leq$.001 " " " D = 0

" " " $\geq$.999 " " " D = 1

31. Mean of the j^{th} alternative of item i $\quad \bar{X}_{ij} = \sum_{k=1}^{N_i} X_{ijk} / N_i$

where N_i = N if the test was a power test and

= the number of people reaching item i if the test was a speed test.

32. Standar Deviation of the jth alternative of item i

$$SD_{ij} = \sqrt{\bar{X}_{ij}\,(1-\bar{X}_{ij})}$$

33. Correlation between alternatives a and b if item i

$$r_{ab} = \sqrt{\frac{\bar{X}_{ia}\ \bar{X}_{ib}}{(1-\bar{X}_{ia})(1-\bar{X}_{ib})}}$$

(Formulas 31 and 32 are derived from the regular formulas by noting that the individual values of the alternatives are 1's and 0's only and that the alternatives are mutually exclusive.)

34. Point-Biserial correlation between the criterion Y and the jth alternatives of item i

$$ {}^{phis}r_{jY} = \frac{\sum_{K=1}^{N_i} X_{ijk} Y_K / N_i - \bar{X}_{ij} \bar{Y}_i}{SD_{ij} \; SD_{yi}} $$

(Note that in a speed test $\bar{Y}_i$ and SD_{yi} are based on the N_i reaching item i; in a power test, they are computed on the full sample).

35. Biserial correlation between the criterion Y and the jth alternative of item i

$$ {}_{bis}r_{jY} = \frac{{}^{phis}r_{ij} \cdot SD_{ij}}{Z} $$

where Z = the ordinate of the unit normal distribution curve with area equal to 1.0, at the point of division between segments containing p and q ($\bar{X}_{ij}$ and $1-\bar{X}_{ij}$) proportions of the cases.

36. Biserial validity significance test value =

$$\text{RTEST} = \frac{r_{bis_{jy}} \sqrt{N_i}}{SD_{cj}/z - r^2_{bis_{jy}}}$$

the significance test is $r_{bis_{jy}}$ is then:

$P \leq .05$ if RTEST ≥ 1.96

$P \leq .01$ if RTEST ≥ 2.576

APPENDIX B

IAP Sample Run

IAP : ITEM ANALYSIS PROGRAM

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

IAP CLASS RUN

SPECIFIED CONTROL PARAMETERS

NSTITM=	30	IUPLIM=	4	NFM=	1	KI=	10	KO=	0	KS=	13	NB=	35	EASY=	.80
DIFFLT=	.70	IALPHA=	0	NSPEED=	0	ICORGS=	1	KIV=	0	ICRIT=	0	OUT=	.0	NOCASE=	0
IPHI=	1	IFREQ=	2	IOVER=	0	JPLOT=	0	NF=	10	EIGN=	1.00	IDEND=	0	IRWIND=	0
IOUT=	0	ATEST=		IALT=	1	ICARD=	0	IHAM=	0	NERR=	2	KS2=	11	KERR=	0

TITLE: IAP CLASS RUN

INPUT FORMAT FOR DATA ON FORTRAN FILE
(3X,A6/11X,30I1)

NUMERIC ANSWER KEY GIVEN
122213323342323332232322342222

ALTERNATE RESPONSE CARD GIVEN
4. 3. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4.

NUMBER OF ITEMS IS 30

FIRST RECORD READ ID IS 1
RESPONSES READ 223223333342423323243324433311

IAP : ITEM ANALYSIS PROGRAM — CONTROLLED ITEM — MANPOWER AND PERSONNEL DIVISIO

*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) *** — AF HUMAN RESOURCES LABORATORY

IAP CLASS RUN — AIR FORCE SYSTEMS COMMAND

ITEM NUMBER	ITEM INFORMATION DIFFICULTY	OMITS	PROPORTION OF 225 SUBJECTS SELECTING EACH RESPONSE 1	2	3	4
1	-.191	.000	.107	.627	.249	.018
2	.547	.000	.231	.698	.071	
3	.401	.000	.138	.551	.284	.027
4	.259	.000	.044	.444	.440	.071
5	-.126	.000	.156	.431	.369	.044
6	.028	.000	.218	.476	.271	.036
7	.230	.000	.027	.204	.422	.347
8	.336	.000	.062	.502	.387	.049
9	.366	.000	.044	.369	.524	.062
10	.301	.000	.084	.280	.476	.160
11	.396	.000	.013	.107	.333	.547
12	.324	.000	.062	.493	.351	.093
13	.361	.004	.036	.329	.520	.111
14	.502	.000	.240	.627	.102	.031
15	.265	.000	.053	.160	.449	.338
16	.360	.000	.036	.378	.520	.067
17	.579	.000	.009	.222	.684	.084
18	.567	.000	.173	.676	.142	.009
19	.479	.000	.271	.609	.102	.018
20	.295	.000	.058	.351	.471	.120
21	.413	.000	.076	.560	.333	.031
22	.313	.000	.040	.418	.484	.058
23	.526	.000	.196	.644	.142	.018
24	.354	.000	.116	.516	.316	.053
25	.295	.000	.049	.387	.471	.093
26	-.073	.000	.022	.178	.604	.196
27	.456	.004	.067	.591	.316	.022
28	.479	.000	.076	.609	.302	.013
29	.526	.000	.182	.644	.169	.004
30	.396	.000	.191	.547	.244	.018

IAP : ITEM ANALYSIS PROGRAM

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

IAP CLASS RUN

THE FOLLOWING ITEMS FALL OUTSIDE OF THE SPECIFIED DIFFICULTY RANGE AND SHOULD BE ELIMINATED BECAUSE OF EXTREME DIFFICULTY/EASINESS

EASY ITEMS ABOVE .80 DIFFICULT ITEMS BELOW .20

1
5
6
26

IAP : ITEM ANALYSIS PROGRAM — CONTROLLED ITEM — MANPOWER AND PERSONNEL DIVIS

*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) *** — AF HUMAN RESOURCES LABORATO

IAP CLASS RUN — AIR FORCE SYSTEMS COMMAN

ITEM ALTERNATIVE INFORMATION ROSTER (BASED ON "CORRECTED TEST SCORE" CRITERION)

ITEM-ALT	MEAN	STD DEV	DIFF.	CRIT. VALIDITY PT BIS	BIS		ALTERNATIVE INTERCORRELATIONS OMIT	1	2	3	4	5	6	7
1-OMIT	.0000	.0000		.0000	.0000		1.000							
1-1 *	.1067	.3087	.000	.0000	.0000		.000	1.000						
1-2	.6267	.4837	.502	.0638	.0799		.000	-.448	1.000					
1-3	.2489	.4324	.000	.0000	.0000		.000	-.199	-.746	1.000				
1-4	.0178	.1324	.000	.0000	.0000		.000	-.046	-.174	-.077	1.000			
2-OMIT	.0000	.0000		.0000	.0000		1.000							
2-1	.2311	.4215	.000	.0000	.0000		.000	1.000						
2-2 *	.6978	.4592	.547	.2871	.3607	**	.000	-.833	1.000					
2-3	.0711	.2570	.000	.0000	.0000		.000	-.152	-.420	1.000				
3-OMIT	.0000	.0000		.0000	.0000		1.000							
3-1	.1378	.3447	.000	.0000	.0000		.000	1.000						
3-2 *	.5511	.4974	.401	.1743	.2210	**	.000	-.443	1.000					
3-3	.2844	.4511	.046	-.0518	-.1125		.000	-.252	-.699	1.000				
3-4	.0267	.1611	.000	.0000	.0000		.000	-.066	-.183	-.104	1.000			
4-OMIT	.0000	.0000		.0000	.0000		1.000							
4-1	.0444	.2061	.000	.0000	.0000		.000	1.000						
4-2 *	.4444	.4969	.259	.0411	.0557		.000	-.193	1.000					
4-3	.4400	.4964	.253	-.0204	-.0277		.000	-.191	-.793	1.000				
4-4	.0711	.2570	.000	.0000	.0000		.000	-.060	-.247	-.245	1.000			
5-OMIT	.0000	.0000		.0000	.0000		1.000							
5-1 *	.1556	.3624	.000	.0000	.0000		.000	1.000						
5-2	.4311	.4952	.241	.1032	.1416		.000	-.374	1.000					
5-3	.3689	.4825	.159	-.0723	-.1091		.000	-.328	-.666	1.000				
5-4	.0444	.2061	.000	.0000	.0000		.000	-.093	-.188	-.165	1.000			
6-OMIT	.0000	.0000		.0000	.0000		1.000							
6-1	.2178	.4127	.000	.0000	.0000		.000	1.000						
6-2	.4756	.4994	.301	.0443	.0584		.000	-.502	1.000					
6-3 *	.2711	.4445	.028	.0288	.0739		.000	-.322	-.581	1.000				
6-4	.0356	.1852	.000	.0000	.0000		.000	-.101	-.183	-.117	1.000			
7-OMIT	.0000	.0000		.0000	.0000		1.000							
7-1	.0267	.1611	.000	.0000	.0000		.000	1.000						
7-2	.2044	.4033	.000	.0000	.0000		.000	-.084	1.000					
7-3 *	.4222	.4939	.230	.2046	.2836	**	.000	-.141	-.433	1.000				
7-4	.3467	.4759	.129	-.1110	-.1769	*	.000	-.121	-.369	-.623	1.000			
8-OMIT	.0000	.0000		.0000	.0000		1.000							
8-1	.0622	.2416	.000	.0000	.0000		.000	1.000						
8-2 *	.5022	.5000	.336	.1268	.1642	*	.000	-.259	1.000					
8-3	.3867	.4870	.182	-.0425	-.0621		.000	-.205	-.798	1.000				
8-4	.0489	.2156	.000	.0000	.0000		.000	-.058	-.228	-.130	1.000			

* FLAGS CORRECT ANSWER

* INDICATES BISERIAL VALIDITY SIGNIFICANT AT .05 LEVEL & ** FOR .01 LE

IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

ITEM ALTERNATIVE INFORMATION ROSTER (BASED ON "CORRECTED TEST SCORE" CRITERION)

ITEM-ALT	MEAN	STD DEV	DIFF.	CRIT. VALIDITY PT BIS	BIS		ALTERNATIVE INTERCORRELATIONS OMIT	1	2	3	4	5	6	7	8
9-OMIT	.0000	.0000		.0000	.0000		1.000								
9-1	.0444	.2061	.000	.0000	.0000		.000	1.000							
9-2	.3689	.4825	.159	-.0106	-.0160		.000	-.165	1.000						
9-3 *	.5244	.4994	.366	.1475	.1889	*	.000	-.226	-.803	1.000					
9-4	.0622	.2416	.000	.0000	.0000		.000	-.056	-.197	-.271	1.000				
10-OMIT	.0000	.0000		.0000	.0000		1.000								
10-1	.0844	.2781	.000	.0000	.0000		.000	1.000							
10-2	.2800	.4490	.040	-.0208	-.0473		.000	-.189	1.000						
10-3 *	.4756	.4994	.301	.2143	.2823	**	.000	-.289	-.596	1.000					
10-4	.1600	.3666	.000	.0000	.0000		.000	-.133	-.272	-.416	1.000				
11-OMIT	.0000	.0000		.0000	.0000		1.000								
11-1	.0133	.1147	.000	.0000	.0000		.000	1.000							
11-2	.1067	.3087	.000	.0000	.0000		.000	-.040	1.000						
11-3	.3333	.4714	.111	.0119	.0197		.000	-.082	-.244	1.000					
11-4 *	.5467	.4978	.396	.1072	.1361		.000	-.128	-.379	-.776	1.000				
12-OMIT	.0000	.0000		.0000	.0000		1.000								
12-1	.0622	.2416	.000	.0000	.0000		.000	1.000							
12-2 *	.4933	.5000	.324	.2052	.2671	**	.000	-.254	1.000						
12-3	.3511	.4773	.135	-.0754	-.1187		.000	-.189	-.726	1.000					
12-4	.0933	.2909	.000	.0000	.0000		.000	-.083	-.317	-.236	1.000				
13-OMIT	.0044	.0665		-.0556	-.2842		1.000								
13-1	.0356	.1852	.000	.0000	.0000		-.013	1.000							
13-2	.3289	.4698	.107	-.0700	-.1175		-.047	-.134	1.000						
13-3 *	.5200	.4996	.361	.1934	.2479	**	-.070	-.200	-.729	1.000					
13-4	.1111	.3143	.000	.0000	.0000		-.024	-.068	-.248	-.368	1.000				
14-OMIT	.0000	.0000		.0000	.0000		1.000								
14-1	.2400	.4271	.000	.0000	.0000		.000	1.000							
14-2 *	.6267	.4837	.502	.2772	.3474	**	.000	-.728	1.000						
14-3	.1022	.3029	.000	.0000	.0000		.000	-.190	-.437	1.000					
14-4	.0311	.1736	.000	.0000	.0000		.000	-.101	-.232	-.060	1.000				
15-OMIT	.0000	.0000		.0000	.0000		1.000								
15-1	.0533	.2247	.000	.0000	.0000		.000	1.000							
15-2	.1600	.3666	.000	.0000	.0000		.000	-.104	1.000						
15-3 *	.4489	.4974	.265	.2355	.3172	**	.000	-.214	-.394	1.000					
15-4	.3378	.4730	.117	-.0810	-.1325		.000	-.170	-.312	-.645	1.000				
16-OMIT	.0000	.0000		.0000	.0000		1.000								
16-1	.0356	.1852	.000	.0000	.0000		.000	1.000							
16-2	.3778	.4848	.170	-.0711	-.1054		.000	-.150	1.000						
16-3 *	.5200	.4996	.360	.1859	.2386	**	.000	-.200	-.811	1.000					
16-4	.0667	.2494	.000	.0000	.0000		.000	-.051	-.208	-.278	1.000				

* FLAGS CORRECT ANSWER

* INDICATES BISERIAL VALIDITY SIGNIFICANT AT .05 LEVEL & ** FOR .01 LEVEL.

IAP : ITEM ANALYSIS PROGRAM — CONTROLLED ITEM — MANPOWER AND PERSONNEL DIVISIO

*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) *** — AF HUMAN RESOURCES LABORATORY

IAP CLASS RUN — AIR FORCE SYSTEMS COMMAND

ITEM ALTERNATIVE INFORMATION ROSTER (BASED ON "CORRECTED TEST SCORE" CRITERION)

ITEM-ALT	MEAN	STD DEV	DIFF.	CRIT. VALIDITY PT BIS	BIS		ALTERNATIVE INTERCORRELATIONS OMIT	1	2	3	4	5	6	7	8
17-OMIT	.0000	.0000		.0000	.0000		1.000								
17-1	.0089	.0939	.000	.0000	.0000		.000	1.000							
17-2	.2222	.4157	.000	.0000	.0000		.000	-.051	1.000						
17-3 *	.6844	.4647	.579	.2051	.2589	**	.000	-.139	-.787	1.000					
17-4	.0844	.2781	.000	.0000	.0000		.000	-.029	-.162	-.447	1.000				
18-OMIT	.0000	.0000		.0000	.0000		1.000								
18-1	.1733	.3785	.000	.0000	.0000		.000	1.000							
18-2 *	.6756	.4682	.567	.2115	.2665	**	.000	-.661	1.000						
18-3	.1422	.3493	.000	.0000	.0000		.000	-.186	-.588	1.000					
18-4	.0089	.0939	.000	.0000	.0000		.000	-.043	-.137	-.039	1.000				
19-OMIT	.0000	.0000		.0000	.0000		1.000								
19-1	.2711	.4445	.028	-.0717	-.1836		.000	1.000							
19-2 *	.6089	.4880	.479	.2736	.3431	**	.000	-.761	1.000						
19-3	.1022	.3029	.000	.0000	.0000		.000	-.206	-.421	1.000					
19-4	.0178	.1321	.000	.0000	.0000		.000	-.082	-.168	-.045	1.000				
20-OMIT	.0000	.0000		.0000	.0000		1.000								
20-1	.0578	.2333	.000	.0000	.0000		.000	1.000							
20-2	.3511	.4773	.135	-.0197	-.0311		.000	-.182	1.000						
20-3 *	.4711	.4992	.295	.1510	.1996	**	.000	-.234	-.694	1.000					
20-4	.1200	.3250	.000	.0000	.0000		.000	-.091	-.272	-.349	1.000				
21-OMIT	.0000	.0000		.0000	.0000		1.000								
21-1	.0756	.2643	.000	.0000	.0000		.000	1.000							
21-2 *	.5600	.4964	.413	.1314	.1661	*	.000	-.323	1.000						
21-3	.3333	.4714	.111	-.0351	-.0583		.000	-.202	-.798	1.000					
21-4	.0311	.1736	.000	.0000	.0000		.000	-.051	-.202	-.127	1.000				
22-OMIT	.0000	.0000		.0000	.0000		1.000								
22-1	.0400	.1960	.000	.0000	.0000		.000	1.000							
22-2	.4178	.4932	.224	-.1321	-.1841	*	.000	-.173	1.000						
22-3 *	.4844	.4998	.313	.1978	.2590	**	.000	-.198	-.821	1.000					
22-4	.0578	.2333	.000	.0000	.0000		.000	-.051	-.210	-.240	1.000				
23-OMIT	.0000	.0000		.0000	.0000		1.000								
23-1	.1956	.3966	.000	.0000	.0000		.000	1.000							
23-2 *	.6444	.4787	.526	.2938	.3685	**	.000	-.664	1.000						
23-3	.1422	.3493	.000	.0000	.0000		.000	-.201	-.548	1.000					
23-4	.0178	.1321	.000	.0000	.0000		.000	-.066	-.181	-.055	1.000				
24-OMIT	.0000	.0000		.0000	.0000		1.000								
24-1	.1156	.3197	.000	.0000	.0000		.000	1.000							
24-2 *	.5156	.4998	.354	.1676	.2155	**	.000	-.373	1.000						
24-3	.3156	.4647	.087	-.0253	-.0450		.000	-.245	-.700	1.000					
24-4	.0533	.2247	.000	.0000	.0000		.000	-.086	-.245	-.161	1.000				

* FLAGS CORRECT ANSWER

* INDICATES BISERIAL VALIDITY SIGNIFICANT AT .05 LEVEL & ** FOR .01 LEVEL.

IAP : ITEM ANALYSIS PROGRAM — CONTROLLED ITEM — MANPOWER AND PERSONNEL DIVISION

*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) *** — AF HUMAN RESOURCES LABORATORY

IAP CLASS RUN — AIR FORCE SYSTEMS COMMAND

ITEM ALTERNATIVE INFORMATION ROSTER (BASED ON "CORRECTED TEST SCORE" CRITERION)

ITEM-ALT	MEAN	STD DEV	DIFF.	CRIT. VALIDITY PT BIS	BIS		********** ALTERNATIVE INTERCORRELATIONS ********** OMIT	1	2	3	4	5	6	7	8
25-OMIT	.0000	.0000		.0000	.0000		1.000								
25-1	.0489	.2156	.000	.0000	.0000		.000	1.000							
25-2	.3867	.4870	.182	-.0411	-.0600		.000	-.180	1.000						
25-3 *	.4711	.4992	.295	.1548	.2046	**	.000	-.214	-.749	1.000					
25-4	.0933	.2909	.000	.0000	.0000		.000	-.073	-.255	-.303	1.000				
26-OMIT	.0000	.0000		.0000	.0000		1.000								
26-1	.0222	.1474	.000	.0000	.0000		.000	1.000							
26-2	.1778	.3823	.000	.0000	.0000		.000	-.070	1.000						
26-3	.6044	.4890	.473	.0023	.0029		.000	-.186	-.575	1.000					
26-4 *	.1956	.3966	.000	.0000	.0000		.000	-.074	-.229	-.609	1.000				
27-OMIT	.0044	.0665		-.0337	-.1720		1.000								
27-1	.0667	.2494	.000	.0000	.0000		-.018	1.000							
27-2 *	.5911	.4916	.456	.2585	.3247	**	-.080	-.321	1.000						
27-3	.3156	.4647	.089	-.0985	-.1742		-.045	-.181	-.816	1.000					
27-4	.0222	.1474	.000	.0000	.0000		-.010	-.040	-.181	-.102	1.000				
28-OMIT	.0000	.0000		.0000	.0000		1.000								
28-1	.0756	.2643	.000	.0000	.0000		.000	1.000							
28-2 *	.6089	.4880	.479	.1541	.1932	**	.000	-.357	1.000						
28-3	.3022	.4592	.070	-.0467	-.0888		.000	-.188	-.821	1.000					
28-4	.0133	.1147	.000	.0000	.0000		.000	-.033	-.145	-.077	1.000				
29-OMIT	.0000	.0000		.0000	.0000		1.000								
29-1	.1922	.3860	.000	.0000	.0000		.000	1.000							
29-2 *	.6444	.4787	.526	.1682	.2110	**	.000	-.636	1.000						
29-3	.1689	.3747	.000	.0000	.0000		.000	-.213	-.607	1.000					
29-4	.0044	.0665	.000	.0000	.0000		.000	-.032	-.090	-.030	1.000				
30-OMIT	.0000	.0000		.0000	.0000		1.000								
30-1	.1911	.3932	.000	.0000	.0000		.000	1.000							
30-2 *	.5467	.4978	.396	.2531	.3213	**	.000	-.534	1.000						
30-3	.2444	.4298	.000	.0000	.0000		.000	-.276	-.625	1.000					
30-4	.0178	.1321	.000	.0000	.0000		.000	-.065	-.148	-.077	1.000				

* FLAGS CORRECT ANSWER

* INDICATES BISERIAL VALIDITY SIGNIFICANT AT .05 LEVEL & ** FOR .01 LEVEL.

IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISIO
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

SUMMARY OF TEST STATISTICS

VARIABLE	MEAN	S.E.	ST.DEV.	S.E.	SKEWNESS	S.E.	KURTOSIS	S.E.	NO. OF SUBJECTS
RAW SCORE	15.01	.23	3.41	.18	-.25	.16	.50	.32	225
CORRECTED SCORE	9.96	.30	4.57	.24	-.25	.16	.50	.32	225

TEST RELIABILITY= .760

IAP : ITEM ANALYSIS PROGRAM

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

IAP CLASS RUN

FREQUENCY DISTRIBUTION OF SCORES

SCORE	Z-SCORE	T-SCORE	FREQUENCY	PERCENT	HISTOGRAM - EACH) = .5 PERCENT
ZERO OR LESS			6		
1	-1.96	30.39	3	1.3	*))
3	-1.52	3 .7	11	4.9	*))))))))))
5	-1.09	3	11	4.9	*))))))))))
6	-.87	41.	18	8.0	*))))))))))))))))
7	-.65	43.52	18	8.0	*))))))))))))))))
8	-.43	45.	1	.4	*
9	-.21	47	28	12.4	*))))))))))))))))))))))))))
10	.01	5	26	11.6	*))))))))))))))))))))))))
11	.23	52.26	29	12.9	*))))))))))))))))))))))))))))
13	.66	56.64	26	11.6	*))))))))))))))))))))))))
14	.88	58.83	16	7.1	*))))))))))))))
15	1.10	61.01	15	6.7	*))))))))))))))
17	1.54	65.39	5	2.2	*))))
18	1.76	67.58	5	2.2	*))))
19	1.98	69.76	4	1.8	*)))
21	2.41	74.14	2	.9	*)
22	2.63	76.32	1	.4	*

IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

INDIVIDUAL SCORES

ID	RAW SCORE	RAW Z-SCORE	RAW T-SCORE	CORRECTED SCORE	CORRECTED Z-SCORE	CORRECTED T-SCORE	OMITS
1	14	-.296	47.040	8.67	-.284	47.162	0
2	16	.291	52.908	11.33	.299	52.994	0
3	14	-.296	47.040	8.67	-.284	47.162	0
4	16	.291	52.908	11.33	.299	52.994	0
5	4	-3.230	17.699	-4.83	-3.237	17.635	0
6	8	-2.056	29.435	.67	-2.034	29.664	0
7	17	.584	55.842	12.67	.591	55.910	0
8	23	2.345	73.447	20.67	2.341	73.407	0
9	17	.584	55.842	12.67	.591	55.910	0
10	13	-.589	44.106	7.33	-.575	44.245	0
11	16	.291	52.908	11.33	.299	52.994	0
12	12	-.883	41.172	6.00	-.867	41.329	0
13	17	.584	55.842	12.50	.555	55.546	0
14	16	.291	52.908	11.17	.263	52.629	0
15	14	-.296	47.040	8.50	-.320	46.797	0
16	12	-.883	41.172	5.83	-.904	40.965	0
17	15	-.003	49.974	10.00	.008	50.078	0
18	10	-1.470	35.304	3.33	-1.450	35.497	0
19	17	.584	55.842	12.50	.555	55.546	0
20	14	-.296	47.040	8.67	-.284	47.162	0
21	13	-.589	44.106	7.17	-.612	43.881	0
22	16	.291	52.908	11.17	.263	52.629	0
23	13	-.589	44.106	7.17	-.612	43.881	0
24	12	-.883	41.172	5.83	-.904	40.965	0
25	16	.291	52.908	11.33	.299	52.994	0
26	17	.584	55.842	12.67	.591	55.910	0
27	7	-2.350	26.501	-.83	-2.362	26.384	0
28	19	1.171	61.710	15.33	1.174	61.743	0
29	18	.878	58.776	14.00	.883	58.826	0
30	16	.291	52.908	11.17	.263	52.629	0
31	14	-.296	47.040	8.67	-.284	47.162	0
32	19	1.171	61.710	15.33	1.174	61.743	0
33	13	-.589	44.106	7.33	-.575	44.245	0
34	18	.878	58.776	14.00	.883	58.826	0
35	19	1.171	61.710	15.33	1.174	61.743	0
36	22	2.051	70.512	19.33	2.049	70.491	0
37	18	.878	58.776	14.00	.883	58.826	0
38	16	.291	52.908	11.33	.299	52.994	0
39	16	.291	52.908	11.33	.299	52.994	0
40	12	-.883	41.172	6.00	-.867	41.329	0
41	17	.584	55.842	12.67	.591	55.910	0
42	20	1.464	64.644	16.67	1.466	64.659	0
43	16	.291	52.908	11.33	.299	52.994	0
44	10	-1.470	35.304	3.33	-1.450	35.497	0
45	17	.584	55.842	12.67	.591	55.910	0
46	11	-1.176	38.238	4.50	-1.195	38.048	0
47	10	-1.470	35.304	3.17	-1.487	35.132	0
48	16	.291	52.908	11.33	.299	52.994	0
49	17	.584	55.842	12.67	.591	55.910	0
50	14	-.296	47.040	8.50	-.320	46.797	0

IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

INDIVIDUAL SCORES

ID	SCORE	RAW Z-SCORE	T-SCORE	CORRECTED SCORE	CORRECTED Z-SCORE	CORRECTED T-SCORE	OMITS
51	13	-.589	44.106	7.67	-.503	44.974	1
52	19	1.171	61.710	15.17	1.138	61.378	0
53	14	-.296	47.040	8.67	-.284	47.162	0
54	23	2.345	73.447	20.67	2.341	73.407	0
55	6	-2.643	23.567	-2.00	-2.617	23.832	0
56	12	-.883	41.172	6.00	-.867	41.329	0
57	19	1.171	61.710	15.33	1.174	61.743	0
58	11	-1.176	38.238	4.67	-1.159	38.413	0
59	16	.291	52.908	11.33	.299	52.994	0
60	18	.878	58.776	14.00	.883	58.826	0
61	19	1.171	61.710	15.33	1.174	61.743	0
62	15	-.003	49.974	10.00	.008	50.078	0
63	17	.584	55.842	12.50	.555	55.546	0
64	15	-.003	49.974	10.00	.008	50.078	0
65	22	2.051	70.512	19.33	2.049	70.491	0
66	19	1.171	61.710	15.33	1.174	61.743	0
67	17	.584	55.842	12.67	.591	55.910	0
68	17	.584	55.842	12.67	.591	55.910	0
69	17	.584	55.842	12.50	.555	55.546	0
70	16	.291	52.908	11.33	.299	52.994	0
71	14	-.296	47.040	8.50	-.320	46.797	0
72	15	-.003	49.974	10.00	.008	50.078	0
73	13	-.589	44.106	7.17	-.612	43.881	0
74	13	-.589	44.106	7.33	-.575	44.245	0
75	14	-.296	47.040	8.67	-.284	47.162	0
76	19	1.171	61.710	15.33	1.174	61.743	0
77	18	.878	58.776	14.00	.883	58.826	0
78	20	1.464	64.644	16.50	1.429	64.294	0
79	16	.291	52.908	11.33	.299	52.994	0
80	16	.291	52.908	11.33	.299	52.994	0
81	13	-.589	44.106	7.33	-.575	44.245	0
82	12	-.883	41.172	6.00	-.867	41.329	0
83	12	-.883	41.172	6.00	-.867	41.329	0
84	16	.291	52.908	11.33	.299	52.994	0
85	19	1.171	61.710	15.33	1.174	61.743	0
86	14	-.296	47.040	8.67	-.284	47.162	0
87	13	-.589	44.106	7.33	-.575	44.245	0
88	13	-.589	44.106	7.33	-.575	44.245	0
89	14	-.296	47.040	8.50	-.320	46.797	0
90	15	-.003	49.974	10.00	.008	50.078	0
91	13	-.589	44.106	7.33	-.575	44.245	0
92	11	-1.176	38.238	4.50	-1.195	38.048	0
93	14	-.296	47.040	8.50	-.320	46.797	0
94	10	-1.470	35.304	3.33	-1.450	35.497	0
95	13	-.589	44.106	7.17	-.612	43.881	0
96	15	-.003	49.974	10.00	.008	50.078	0
97	16	.291	52.908	11.33	.299	52.994	0
98	15	-.003	49.974	10.00	.008	50.078	0
99	12	-.883	41.172	5.83	-.904	40.965	0
100	10	-1.470	35.304	3.17	-1.487	35.132	0

IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISIO
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

INDIVIDUAL SCORES

ID	RAW SCORE	RAW Z-SCORE	RAW T-SCORE	CORRECTED SCORE	CORRECTED Z-SCORE	CORRECTED T-SCORE	OMITS
101	15	-.003	49.974	10.00	.008	50.078	0
102	11	-1.176	38.238	4.50	-1.195	38.048	0
103	16	.291	52.908	11.33	.299	52.994	0
104	12	-.883	41.172	6.00	-.867	41.329	0
105	17	.584	55.842	12.50	.555	55.546	0
106	16	.291	52.908	11.33	.299	52.994	0
107	12	-.883	41.172	6.00	-.867	41.329	0
108	21	1.758	67.578	18.00	1.758	67.575	0
109	16	.291	52.908	11.33	.299	52.994	0
110	17	.584	55.842	12.67	.591	55.910	0
111	20	1.464	64.644	16.67	1.466	64.659	0
112	19	1.171	61.710	15.33	1.174	61.743	0
113	13	-.589	44.106	7.17	-.612	43.881	0
114	14	-.296	47.040	8.50	-.320	46.797	0
115	14	-.296	47.040	8.50	-.320	46.797	0
116	21	1.758	67.578	18.00	1.758	67.575	0
117	16	.291	52.908	11.33	.299	52.994	0
118	11	-1.176	38.238	4.50	-1.195	38.048	0
119	12	-.883	41.172	6.17	-.831	41.694	1
120	19	1.171	61.710	15.17	1.138	61.378	0
121	11	-1.176	38.238	4.50	-1.195	38.048	0
122	8	-2.056	29.435	.50	-2.070	29.307	0
123	17	.584	55.842	12.67	.591	55.910	0
124	11	-1.176	38.238	4.50	-1.195	38.048	0
125	22	2.051	70.512	19.33	2.049	70.491	0
126	20	1.464	64.644	16.67	1.466	64.659	0
127	11	-1.176	38.238	4.50	-1.195	38.048	0
128	14	-.296	47.040	8.67	-.284	47.162	0
129	21	1.758	67.578	18.00	1.758	67.575	0
130	5	-2.937	20.633	-3.50	-2.945	20.551	0
131	16	.291	52.908	11.17	.263	52.629	0
132	11	-1.176	38.238	4.67	-1.159	38.413	0
133	15	-.003	49.974	10.00	.008	50.078	0
134	15	-.003	49.974	9.83	-.029	49.713	0
135	17	.584	55.842	12.67	.591	55.910	0
136	15	-.003	49.974	10.00	.008	50.078	0
137	14	-.296	47.040	8.67	-.284	47.162	0
138	8	-2.056	29.435	.67	-2.034	29.664	0
139	14	-.296	47.040	8.67	-.284	47.162	0
140	14	-.296	47.040	8.67	-.284	47.162	0
141	16	.291	52.908	11.33	.299	52.994	0
142	18	.878	58.776	14.00	.883	58.826	0
143	15	-.003	49.974	10.00	.008	50.078	0
144	18	.878	58.776	13.83	.846	58.462	0
145	16	.291	52.908	11.33	.299	52.994	0
146	17	.584	55.842	12.67	.591	55.910	0
147	24	2.638	76.381	22.00	2.632	76.324	0
148	14	-.296	47.040	8.50	-.320	46.797	0
149	14	-.296	47.040	8.50	-.320	46.797	0
150	15	-.003	49.974	9.83	-.029	49.713	0

IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

INDIVIDUAL SCORES

ID	SCORE	RAW Z-SCORE	RAW T-SCORE	CORRECTED SCORE	CORRECTED Z-SCORE	CORRECTED T-SCORE	OMITS
151	15	-.003	49.974	9.83	-.029	49.713	0
152	18	.878	58.776	14.00	.883	58.826	0
153	15	-.003	49.974	9.83	-.029	49.713	0
154	17	.584	55.842	12.67	.591	55.910	0
155	21	1.758	67.578	18.00	1.758	67.575	0
156	17	.584	55.842	12.67	.591	55.910	0
157	15	-.003	49.974	9.83	-.029	49.713	0
158	15	-.003	49.974	10.00	.008	50.078	0
159	18	.878	58.776	14.00	.883	58.826	0
160	15	-.003	49.974	10.00	.008	50.078	0
161	13	-.589	44.106	7.17	-.612	43.881	0
162	17	.584	55.842	12.67	.591	55.910	0
163	17	.584	55.842	12.67	.591	55.910	0
164	19	1.171	61.710	15.33	1.174	61.743	0
165	14	-.295	47.040	8.50	-.320	46.797	0
166	20	1.464	64.644	16.67	1.466	64.659	0
167	22	2.051	70.512	19.33	2.049	70.491	0
168	19	1.171	61.710	15.33	1.174	61.743	0
169	13	-.589	44.106	7.17	-.612	43.881	0
170	11	-1.176	38.238	4.50	-1.195	38.048	0
171	12	-.883	41.172	5.83	-.904	40.965	0
172	10	-1.470	35.304	3.17	-1.487	35.132	0
173	14	-.296	47.040	8.50	-.320	46.797	0
174	13	-.589	44.106	7.33	-.575	44.245	0
175	17	.584	55.842	12.67	.591	55.910	0
176	16	.291	52.908	11.33	.299	52.994	0
177	12	-.883	41.172	6.00	-.867	41.329	0
178	11	-1.176	38.238	4.67	-1.159	38.413	0
179	18	.878	58.776	14.00	.883	58.826	0
180	14	-.296	47.040	8.50	-.320	46.797	0
181	17	.584	55.842	12.67	.591	55.910	0
182	13	-.589	44.106	7.33	-.575	44.245	0
183	12	-.883	41.172	5.83	-.904	40.965	0
184	15	-.003	49.974	10.00	.008	50.078	0
185	6	-2.643	23.567	-2.17	-2.653	23.467	0
186	19	1.171	61.710	15.33	1.174	61.743	0
187	12	-.883	41.172	5.83	-.904	40.965	0
188	19	1.171	61.710	15.33	1.174	61.743	0
189	21	1.758	67.578	18.00	1.758	67.575	0
190	13	-.589	44.106	7.33	-.575	44.245	0
191	16	.291	52.908	11.33	.299	52.994	0
192	10	-1.470	35.304	3.33	-1.450	35.497	0
193	10	-1.470	35.304	3.17	-1.487	35.132	0
194	14	-.296	47.040	8.67	-.284	47.162	0
195	14	-.296	47.040	8.67	-.284	47.162	0
196	18	.878	58.776	14.00	.883	58.826	0
197	15	-.003	49.974	10.00	.008	50.078	0
198	16	.291	52.908	11.33	.299	52.994	0
199	10	-1.470	35.304	3.33	-1.450	35.497	0
200	17	.584	55.842	12.67	.591	55.910	0

CONTROLLED ITEM

*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISIO
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

INDIVIDUAL SCORES

	RAW			CORRECTED		
	Z-SCORE	T-SCORE	SCORE	Z-SCORE	T-SCORE	OMITS
	-.003	49.974	9.83	-.029	49.713	0
	-.296	47.040	8.67	-.284	47.162	0
	-.883	41.172	6.00	-.867	41.329	0
	-.883	41.172	5.83	-.904	40.965	0
	-1.470	35.304	3.33	-1.450	35.497	0
	.584	55.842	12.67	.591	55.910	0
7	-2.350	26.501	-.83	-2.362	26.384	0
	-.296	47.040	8.67	-.284	47.162	0
	-.883	41.172	5.83	-.904	40.965	0
	-.003	49.974	10.00	.008	50.078	0
	.291	52.908	11.17	.263	52.629	0
	-.003	49.974	10.00	.008	50.078	0
	.878	58.776	14.00	.883	58.826	0
	-.003	49.974	10.00	.008	50.078	0
	-.296	47.040	8.67	-.284	47.162	0
	.584	55.842	12.67	.591	55.910	0
	-.589	44.106	7.17	-.612	43.881	0
	.878	58.776	14.00	.883	58.826	0
219	-.003	49.974	10.00	.008	50.078	0
220	-1.470	35.304	3.17	-1.487	35.132	0
221	.878	58.776	14.00	.883	58.826	0
222	.291	52.908	11.33	.299	52.994	0
223	.878	58.776	14.00	883	58.826	0
224	.878	58.776	14.00	.883	58.826	0
225	-.003	49.974	10.00	.008	50.078	0

IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

PHI CORRELATION COEFFICIENTS (BASED ON MEDIAN)

ITEM	PHI
1	-.003
2	.451
3	.094
4	-.012
5	.021
6	.013
7	.218
8	.147
9	.116
10	.241
11	.085
12	.256
13	.233
14	.275
15	.283
16	.162
17	.189
18	.208
19	.276
20	.144
21	.146
22	.222
23	.312
24	.189
25	.233
26	-.001
27	.278
28	.240
29	.126
30	.265

IAP : ITEM ANALYSIS PROGRAM — CONTROLLED ITEM — MANPOWER AND PERSONNEL DIVISI

*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) *** — AF HUMAN RESOURCES LABORATORY

IAP CLASS RUN — AIR FORCE SYSTEMS COMMAND

ITEM ANALYSIS SUMMARY TABLE

ITEM	DIFFICULTY PROP'N.	DIFFICULTY STD.	STANDARD DEVIATION	BISERIAL CORR.	BISERIAL T-TEST	POINT BISERIAL CORR.	POINT BISERIAL T-TEST	X-FIFTY	BETA	REL. INDEX
1				UNDEFINED - CHECK ITEM DIFFICULTY						
2	.547	.519	.498	.263	4.063	.209	3.191	-.447	.272	.104
	OVERLAP	CORRECTED		.128	1.926	.102	1.528	-.917	.129	.051
3	.401	.460	.490	.134	2.026	.106	1.593	1.856	.136	.052
	OVERLAP	CORRECTED		-.001	-.022	-.001	-.018	167.891	-.001	-.001
4	.259	.396	.438	-.010	-.142	-.007	-.105	67.739	-.010	-.003
	OVERLAP	CORRECTED		-.138	-2.088	-.102	-1.537	4.662	-.140	-.045
5				UNDEFINED - CHECK ITEM DIFFICULTY						
6	.028	.192	.165	.041	.612	.016	.238	46.638	.041	.007
	OVERLAP	CORRECTED		-.052	-.774	-.020	-.302	36.860	-.052	-.008
7	.230	.360	.421	.222	3.400	.160	2.422	3.334	.228	.067
	OVERLAP	CORRECTED		.095	1.432	.069	1.031	7.754	.096	.029
8	.736	.432	.472	.096	1.446	.074	1.114	4.385	.097	.035
	OVERLAP	CORRECTED		-.038	-.561	-.029	-.433	11.264	-.038	-.014
9	.366	.445	.482	.116	1.740	.090	1.355	2.961	.117	.044
	OVERLAP	CORRECTED		-.019	-.287	-.015	-.224	17.817	-.019	-.007
10	.701	.416	.459	.212	3.233	.161	2.430	2.468	.216	.074
	OVERLAP	CORRECTED		.080	1.204	.061	.912	6.501	.081	.028
11	.396	.457	.489	.061	.912	.048	.718	4.346	.061	.023
	OVERLAP	CORRECTED		-.075	-1.120	-.059	-.881	3.542	-.075	-.029
12	.324	.426	.468	.194	2.948	.149	2.247	2.351	.197	.070
	OVERLAP	CORRECTED		.061	.912	.047	.700	7.467	.061	.022
13	.361	.443	.480	.170	2.574	.132	1.995	2.087	.172	.064
	OVERLAP	CORRECTED		.035	.529	.028	.412	10.018	.035	.013
14	.502	.501	.500	.250	3.855	.199	3.040	-.022	.258	.100
	OVERLAP	CORRECTED		.115	1.725	.092	1.373	-.049	.116	.046
15	.265	.399	.441	.253	3.912	.188	2.860	2.476	.262	.083
	OVERLAP	CORRECTED		.125	1.882	.093	1.392	5.018	.126	.041
16	.360	.442	.480	.164	2.482	.128	1.924	2.186	.166	.061
	OVERLAP	CORRECTED		.030	.441	.023	.344	12.143	.030	.011
17	.579	.532	.494	.150	2.271	.119	1.791	-1.330	.152	.059
	OVERLAP	CORRECTED		.014	.211	.011	.167	-14.127	.014	.006
18	.567	.527	.495	.154	2.335	.123	1.845	-1.099	.156	.061
	OVERLAP	CORRECTED		.018	.270	.014	.215	-9.382	.018	.007
19	.479	.491	.500	.245	3.777	.196	2.978	.220	.253	.098
	OVERLAP	CORRECTED		.110	1.651	.088	1.314	.490	.111	.044
20	.295	.413	.456	.132	1.986	.100	1.497	4.091	.133	.045
	OVERLAP	CORRECTED		.000	.001	.000	.000	15529.874	.000	.000
21	.413	.465	.492	.082	1.228	.065	.970	2.673	.082	.032
	OVERLAP	CORRECTED		-.054	-.812	-.043	-.642	4.033	-.054	-.021
22	.313	.421	.464	.191	2.907	.146	2.203	2.556	.195	.068
	OVERLAP	CORRECTED		.059	.882	.045	.673	8.288	.059	.021
23	.526	.511	.499	.267	4.143	.213	3.258	-.243	.277	.106
	OVERLAP	CORRECTED		.133	1.999	.106	1.588	-.490	.134	.053
24	.354	.440	.478	.137	2.060	.106	1.596	2.740	.138	.051
	OVERLAP	CORRECTED		.002	.032	.002	.025	173.192	.002	.001
25	.295	.413	.456	.144	2.176	.109	1.639	3.740	.146	.050
	OVERLAP	CORRECTED		.012	.186	.009	.141	43.312	.012	.004

IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

ITEM ANALYSIS SUMMARY TABLE

ITEM	DIFFICULTY PROP'N.	DIFFICULTY STD.	STANDARD DEVIATION	BISERIAL CORR.	BISERIAL T-TEST	POINT BISERIAL CORR.	POINT BISERIAL T-TEST	X-FIFTY	BETA	REL. INDEX
26				UNDEFINED - CHECK ITEM DIFFICULTY						
27	.456	.482	.498	.230	3.535	.183	2.786	.477	.237	.091
	OVERLAP CORRECTED			.095	1.423	.076	1.131	1.157	.095	.038
28	.479	.491	.500	.101	1.522	.081	1.211	.531	.102	.040
	OVERLAP CORRECTED			-.036	-.534	-.028	-.426	1.508	-.036	-.014
29	.526	.511	.499	.106	1.591	.084	1.266	-.614	.107	.042
	OVERLAP CORRECTED			-.031	-.466	-.025	-.371	-2.087	-.031	-.012
30	.396	.457	.489	.244	3.750	.192	2.919	1.088	.251	.094
	OVERLAP CORRECTED			.109	1.644	.086	1.292	2.421	.110	.042

MEAN STANDARDIZED ITEM DIFFICULTY = .402
CORRESPONDING PROPORTION = .272

IAP : ITEM ANALYSIS PROGRAM — CONTROLLED ITEM — MANPOWER AND PERSONNEL DIVISION

*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) *** — AF HUMAN RESOURCES LABORATORY

IAP CLASS RUN — AIR FORCE SYSTEMS COMMAND

PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

ITEM	-4.0	-3.5	-3.0	-2.5	-2.0	-1.5	-1.0	-0.5	0.0	+0.5	+1.0	+1.5	+2.0	+2.5	+3.0	+3.5	+4.0	XFIFTY
1	.00	.00	1.00	.00	.00	.00	.05	.16	.09	.10	.12	.10	.20	.00	.00	.00	.00	.00	UNDEF
2	.00	.00	.00	.33	.40	.00	.41	.54	.47	.90	.96	.85	1.00	1.00	1.00	.00	.00	.00	-.45
3	.00	.00	.00	.00	.40	.00	.76	.57	.56	.43	.60	.85	.60	1.00	1.00	.00	.00	.00	1.86
4	.00	.00	.00	.00	.40	.00	.76	.51	.47	.41	.40	.45	.80	.67	.00	.00	.00	.00	67.74
5	.00	.00	.00	.00	.40	.00	.18	.14	.12	.16	.19	.10	.20	.00	1.00	.00	.00	.00	UNDEF
6	.00	.00	.00	.33	.00	.00	.27	.24	.29	.20	.24	.35	.60	.50	1.00	.00	.00	.00	46.66
7	.00	.00	.00	.00	.20	.00	.73	.75	.24	.41	.43	.75	.80	1.00	1.00	.00	.00	.00	3.33
8	.00	.00	.00	.33	.40	.00	.45	.32	.53	.55	.52	.55	1.00	.67	1.00	.00	.00	.00	4.59
9	.00	.00	.00	.33	.20	.00	.76	.49	.56	.51	.60	.55	1.00	.67	1.00	.00	.00	.00	2.06
10	.00	.00	.00	.00	.00	.00	.27	.35	.47	.49	.60	.75	.80	.50	1.00	.00	.00	.00	2.47
11	.00	.00	.00	.33	.60	.00	.45	.51	.53	.53	.62	.50	.60	1.00	1.00	.00	.00	.00	4.35
12	.00	.00	.00	.33	.00	.00	.76	.24	.53	.51	.74	.50	.80	.67	1.00	.00	.00	.00	2.35
13	.00	.00	.00	.33	.20	.00	.32	.35	.53	.53	.76	.45	.80	.83	1.00	.00	.00	.00	2.09
14	.00	.00	.00	.00	.20	.00	.32	.54	.62	.69	.69	.85	1.00	1.00	1.00	.00	.00	.00	-.02
15	.00	.00	.00	.00	.20	.00	.14	.35	.38	.47	.60	.75	.80	.50	1.00	.00	.00	.00	2.48
16	.00	.00	.00	.00	.40	.00	.23	.51	.53	.53	.62	.60	.60	.83	1.00	.00	.00	.00	2.19
17	.00	.00	1.00	.00	.20	.00	.50	.70	.62	.76	.71	.80	.80	1.00	1.00	.00	.00	.00	-1.33
18	.00	.00	.00	.00	.40	.00	.73	.45	.47	.65	.71	1.00	1.00	1.00	1.00	.00	.00	.00	-1.10
19	.00	.00	.00	.33	.00	.00	.76	.32	.74	.61	.76	.95	.80	1.00	1.00	.00	.00	.00	.22
20	.00	.00	.00	.33	.20	.00	.41	.38	.44	.39	.64	.50	.80	.83	1.00	.00	.00	.00	4.09
21	.00	.00	1.00	.00	.40	.00	.45	.49	.53	.59	.57	.75	.80	.83	.00	.00	.00	.00	2.67
22	.00	.00	.00	.67	.20	.00	.27	.41	.38	.47	.57	.80	.60	.83	1.00	.00	.00	.00	2.56
23	.00	.00	.00	.00	.00	.00	.50	.51	.56	.69	.83	.80	.80	1.00	1.00	.00	.00	.00	-.24
24	.00	.00	.00	.33	.20	.00	.27	.32	.65	.49	.69	.80	.40	.50	.00	.00	.00	.00	2.74
25	.00	.00	.00	.67	.40	.00	.32	.24	.44	.55	.52	.75	.40	.67	1.00	.00	.00	.00	3.74
26	.00	.00	.00	.33	.20	.00	.36	.05	.24	.20	.19	.20	.00	.33	.00	.00	.00	.00	UNDEF
27	.00	.00	.00	.00	.00	.00	.36	.49	.56	.69	.64	.85	.80	.83	1.00	.00	.00	.00	.48
28	.00	.00	.00	.33	.40	.00	.41	.54	.50	.82	.60	.70	.80	.83	.00	.00	.00	.00	.53
29	.00	.00	.00	.33	.40	.00	.45	.57	.74	.61	.79	.65	.80	.83	1.00	.00	.00	.00	-.61
30	.00	.00	.00	.00	.00	.00	.23	.65	.35	.63	.57	.85	.60	1.00	1.00	.00	.00	.00	1.09

IAP : ITEM ANALYSIS PROGRAM

CONTROLLED ITEM

*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

IAP CLASS RUN

TETRACHORIC INTERITEM CORRELATION MATRIX

ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1.00	-.12	.11	.32	-.20	-.20	-.13	-.06	-.28	.04	-.13	-.30	-.09	.06	-.05	-.15	-.03	-.26	.09	.04
2	-.12	1.00	-.21	-.15	-.02	.02	.15	.04	.12	.20	.04	.11	-.02	.37	.27	.39	.09	.20	.30	-.03
3	.11	-.21	1.00	.20	-.11	-.16	.33	.05	-.09	-.11	-.05	-.15	.07	.07	.09	-.10	.07	.07	-.01	.10
4	.32	-.15	.20	1.00	.11	-.16	.02	-.06	-.32	.04	-.16	-.07	-.06	-.08	.00	.08	-.38	.05	.00	-.26
5	-.20	-.02	-.11	.11	1.00	.38	-.04	-.17	.03	.16	.28	.13	.18	-.32	-.18	-.20	-.05	-.13	-.34	-.12
6	-.20	.02	-.16	-.14	.38	1.00	-.09	-.22	.27	.27	.36	.30	.11	-.28	.19	-.12	-.17	-.15	-.04	.04
7	-.13	.15	.30	.02	-.04	-.09	1.00	.15	-.14	-.03	-.11	.17	.07	.22	.15	.13	.03	.18	.12	-.05
8	-.06	.04	.05	-.06	-.17	-.22	.15	1.00	-.12	-.02	.01	.12	.01	.15	.01	.17	-.10	.08	.03	-.15
9	-.28	.12	-.09	-.32	.03	.27	-.14	-.12	1.00	.22	.10	.27	.07	.03	.00	.07	.29	-.02	-.05	.31
10	.04	.20	-.11	.04	.16	.27	-.03	-.02	.22	1.00	.07	.25	.18	-.06	.17	-.07	.06	.21	-.00	-.01
11	-.13	.04	-.05	-.16	.28	.36	-.11	.01	.10	.07	1.00	.18	.09	-.06	-.18	.00	.12	-.00	-.08	.17
12	-.30	.11	-.15	-.07	.13	.30	.17	.12	.27	.25	.18	1.00	.28	-.02	.03	-.08	.00	-.09	.19	.08
13	-.09	-.02	.07	-.06	.18	.11	.07	.01	.07	.18	.09	.28	1.00	.08	.15	.06	.15	.12	.05	-.06
14	.06	.37	.07	-.08	-.32	-.28	.22	.15	.03	-.06	-.06	-.02	.08	1.00	.29	.20	.24	.25	.33	.02
15	-.05	.27	.09	.00	-.18	.19	.15	.01	.00	.17	-.18	.03	.15	.29	1.00	-.04	.25	-.01	.19	.15
16	-.15	.39	-.10	.08	-.20	-.12	.13	.17	.07	-.07	.00	-.08	.06	.20	-.04	1.00	.12	.21	.05	-.09
17	-.03	.09	.07	-.38	-.05	-.17	.03	-.10	.29	.06	.12	.00	.15	.24	.25	.12	1.00	-.04	.14	.23
18	-.26	.20	.07	.05	-.13	-.15	.18	.08	-.02	.21	-.00	-.09	.12	.25	-.01	.21	-.04	1.00	.11	-.08
19	.09	.30	-.01	.00	-.34	-.04	.12	.03	-.05	-.00	-.08	.19	.05	.33	.19	.05	.14	.11	1.00	.10
20	.04	-.03	.10	-.26	-.12	.04	-.05	-.15	.31	-.01	.17	.09	-.06	.02	.15	-.09	.23	-.08	.10	1.00
21	.22	-.09	.38	.17	-.12	-.30	.08	.16	-.23	-.03	-.11	-.06	-.10	-.12	.01	.13	-.07	.15	-.02	-.15
22	-.41	.09	-.00	.02	-.04	.35	.08	-.13	.14	.09	.04	.17	.12	.11	.17	.04	.23	.07	.22	.13
23	-.09	.38	.03	-.01	-.08	.02	.15	.15	.12	.03	-.22	.19	.14	.25	.09	.08	-.08	.20	.38	.05
24	.28	.03	.11	.15	-.19	-.47	-.08	.16	-.16	-.12	-.07	-.12	-.01	.13	-.06	-.06	-.01	-.04	.18	.07
25	-.20	.00	.02	-.20	.12	.11	.06	-.12	-.04	.16	.17	-.01	.02	-.22	.10	-.09	.17	.04	.10	.22
26	-.16	-.08	-.17	-.10	-.13	.14	-.07	-.08	-.04	.08	.08	.09	-.04	-.11	.01	-.12	-.05	-.08	-.20	.09
27	.18	.17	.14	.14	-.03	-.14	.05	.01	-.02	.02	-.08	-.10	.05	.23	.10	.22	-.13	.13	-.03	.07
28	-.04	.18	.13	.18	-.16	-.31	.21	.09	-.26	.08	-.32	-.10	-.07	.21	.25	-.07	-.12	.17	-.04	-.13
29	-.27	.16	-.12	-.28	-.03	.02	-.01	-.02	.15	.00	.08	.01	-.04	.10	-.00	.14	.06	-.03	.18	-.04
30	-.13	.13	.26	.01	-.19	-.05	.23	.09	.13	.10	-.09	.04	-.17	.20	.08	.14	.27	-.07	.29	.11

IAP : ITEM ANALYSIS PROGRAM — CONTROLLED ITEM — MANPOWER AND PERSONNEL DIVISION

*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) *** — AF HUMAN RESOURCES LABORATORY

ISP CLASS RUN — AIR FORCE SYSTEMS COMMAND

TETRACHORIC INTERITEM CORRELATION MATRIX

ITEM	21	22	23	24	25	26	27	28	29	30
21	1.00	-.17	-.07	.33	-.01	-.03	.27	.24	-.13	.00
22	-.17	1.00	.23	-.12	.13	-.05	-.13	-.30	.17	.10
23	-.07	.23	1.00	.13	-.01	-.14	.04	.05	.21	.26
24	.33	-.12	.13	1.00	.20	-.11	.45	.30	.10	-.07
25	-.01	.13	-.01	.20	1.00	.05	.15	-.02	-.07	.00
26	-.03	-.05	-.14	-.11	.05	1.00	-.20	.05	-.22	-.32
27	.27	-.13	.04	.45	.15	-.20	1.00	.29	.16	.12
28	.24	-.30	.05	.30	-.02	.05	.29	1.00	-.04	.06
29	-.13	.17	.21	.10	-.07	-.22	.16	-.04	1.00	.40
30	.00	.10	.26	-.07	.00	-.32	.12	.06	.40	1.00

IAP : ITEM ANALYSIS PROGRAM

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

IAP CLASS RUN

FACTOR ANALYSIS OF 30 ITEMS RESULTED IN 5 FACTORS

FACTOR	RESIDUAL SUMSQ	FACTOR SUMSQ	PERCENT TOT SUMSQ FACTOR	PERCENT TOT SUMSQ ACCUM	EIGENVALUE	PERCENT MAX-V FACTOR	PERCENT MAX-V ACCUM	PERCENT COMMUNALITY FACTOR	PERCENT COMMUNALITY ACCUM
1	25.890	9.045	34.94	34.94	3.007537	10.03	10.03	32.77	32.77
2	16.844	7.436	28.72	63.66	2.726855	9.09	19.11	29.71	62.49
3	9.409	1.728	6.67	70.33	1.314442	4.38	23.50	14.32	76.81
4	7.681	1.286	4.97	75.30	1.134079	3.78	27.28	12.36	89.17
5	6.395	.991	3.83	79.13	.995462	3.32	30.59	10.85	100.02
REST	5.404		20.87	100.00					

IAP : ITEM ANALYSIS PROGRAM

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISI
AF HUMAN RESOURCES LABORATOR
AIR FORCE SYSTEMS COMMAND

IAP CLASS RUN

FACTOR ANALYSIS ** FACTOR LOADINGS

ITEM	COMMUNALITY	1	2	3	4	5
1	.3344	.4026	-.3298	.2357	.0860	-.0244
2	.3607	.0655	.5496	-.2148	-.0947	.0315
3	.2337	.3325	.0119	.0973	.3964	-.0200
4	.3080	.3430	-.2639	-.3244	.1139	.0500
5	.4373	-.4045	-.2333	-.2697	.1929	.3363
6	.5409	-.6787	.0379	-.2070	.1811	.0558
7	.2130	.1943	.2971	-.2289	.1199	-.1422
8	.1142	.2445	.1115	-.1486	-.1408	-.0390
9	.2988	-.4076	.3037	.1757	-.0085	.0973
10	.2108	-.1994	.1578	-.2411	.2766	.0063
11	.2454	-.4096	-.0231	.0697	.1176	.2419
12	.2535	-.3329	.2535	-.2339	.1521	-.0245
13	.1556	-.1443	.1670	-.2042	.2526	-.0277
14	.4198	.3245	.5155	.0329	-.1090	-.1891
15	.3083	.0577	.3484	-.0276	.2949	-.3096
16	.2529	.1645	.3141	-.1408	-.2829	.1650
17	.3713	-.1237	.3646	.4395	.1095	-.1341
18	.1937	.1759	.2545	-.3097	.0231	-.0400
19	.2964	.1626	.5023	.0965	.0116	-.0907
20	.3378	-.1664	.1781	.4557	.2570	-.0628
21	.3181	.4837	-.1520	-.0627	.2209	.0913
22	.2851	-.3203	.4117	-.0215	.0990	-.0543
23	.3051	.1058	.5095	-.1798	-.0325	.0350
24	.4458	.5358	-.0000	.2050	.2368	.2461
25	.2208	-.1322	.0820	.1285	.4129	.0978
26	.2329	-.2131	-.2077	-.0452	.0467	-.3743
27	.4386	.4280	.1379	-.0260	.2730	.4015
28	.3356	.4954	.0428	-.2219	.1542	-.1239
29	.3942	-.0571	.3994	.1133	-.2369	.4030
30	.3142	.1393	.4795	.1750	-.0493	.1786
SUM SQ	9.1768	3.0071	2.7268	1.3147	1.1327	.9955
PERCENT N	30.59	10.02	9.09	4.38	3.78	3.32
PCT. COM.		32.77	29.71	14.33	12.34	10.85

IAP : ITEM ANALYSIS PROGRAM — CONTROLLED ITEM — MANPOWER AND PERSONNEL DIVISION

*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) *** — AF HUMAN RESOURCES LABORATORY

IAP CLASS RUN — AIR FORCE SYSTEMS COMMAND

FACTOR ANALYSIS ** ROTATED FACTOR LOADINGS

ITEM	COMMUNALITY	1	2	3	4	5
1	.3346	.3969	-.0963	-.1699	.3721	-.0176
2	.3607	-.0490	.4458	.3346	-.2005	-.0046
3	.2337	.4511	.1160	-.0306	.0067	.1008
4	.3080	.3275	.0232	-.1194	.0044	-.4312
5	.4373	-.0660	-.4601	.0723	-.4249	-.1995
6	.5409	-.3625	-.2698	-.0674	-.5713	.0760
7	.2100	.1098	.4107	.0125	-.1690	-.0598
8	.1142	.0445	.2369	.1114	.0963	-.1831
9	.2998	-.2849	-.0725	.2088	-.2101	.3529
10	.2109	.0104	.0516	-.0373	-.4545	.0112
11	.2464	-.1316	-.3523	.1054	-.2633	.1534
12	.2535	-.1963	.0821	.0225	-.4529	.0510
13	.1556	.0119	.0934	-.0394	-.3904	.0223
14	.4198	.0351	.5936	.1840	.1108	.1404
15	.3083	.0980	.4059	-.1500	-.2320	.2400
16	.2529	-.0838	.2586	.3919	.0625	-.1466
17	.3713	-.0555	.1398	.0614	.0066	.5873
18	.1937	.0592	.3487	.0954	-.1614	-.1830
19	.2964	.0365	.4340	.2080	-.0190	.2512
20	.3378	.0556	-.0552	-.0351	-.0480	.5728
21	.3181	.5155	.0652	-.0364	.1040	-.1869
22	.2951	-.2371	.1603	.1107	-.3482	.2701
23	.3051	-.0270	.4216	.3053	-.1821	.0133
24	.4458	.6105	.0412	.1776	.1915	.0557
25	.2208	.2050	-.1206	-.0175	-.2898	.2827
26	.2329	-.1928	-.0334	-.4389	-.0426	.0124
27	.4386	.5596	.0611	.3386	-.0671	-.0611
28	.3356	.3807	.3599	-.0888	.0372	-.2277
29	.3942	-.1292	.0245	.6004	-.0009	.1278
30	.3142	.0636	.2528	.4282	.0183	.2502
SUM SQ	9.1768	2.0441	2.2179	1.5043	1.7859	1.6245
PERCENT N	30.59	6.81	7.39	5.01	5.95	5.42
PCT. COM.		22.27	24.17	16.39	19.46	17.70

END OF IAP PASS.

IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN (PROB. 2 - PLOTS)

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

SPECIFIED CONTROL PARAMETERS

NSTITM=	10	IUPLIM=	4	NFM=	1	KI=	10	KO=	0	KS=	13	NB=	35	EASY=	.80	
DIFFLT=	.20	IALPHA=	0	NSPEED=	0	ICORGS=	0	KIV=	0	ICRIT=	0	OUT=	.0	NOCASE=	1	
IPHI=	0	IFREQ=	0	IOVER=	2	JPLOT=	1	NF=	0	EIGN=	.00	IDEND=	0	IRWIND=	0	
IOUT=	0	ATEST=		IALT=	1	ICARD=	0	IHAM=	0	NERR=	2	KS2=	0	KERR=	0	

TITLE: IAP CLASS RUN (PROB. 2 - PLOTS)

INPUT FORMAT FOR DATA ON FORTRAN FILE
(3X,A6/11X,10I1)

NUMERIC ANSWER KEY GIVEN
1222133233

ALTERNATE RESPONSE CARD GIVEN
4. 3. 4. 4. 4. 4. 4. 4. 4. 4.

NUMBER OF ITEMS IS 10

FIRST RECORD READ ID IS 1
RESPONSES READ 2232233333

06

IAP : ITEM ANALYSIS PROGRAM — CONTROLLED ITEM — MANPOWER AND PERSONNEL DIVIS
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) *** — AF HUMAN RESOURCES LABORATO
IAP CLASS RUN (PROB. 2 - PLOTS) — AIR FORCE SYSTEMS COMMAND

SPECIFIED CONTROL PARAMETERS

NSTITM=	10	IUPLIM=	4	NFK=	1	KI=	10	KO=	0	KS=	13	NB=	35	EASY=	
DIFFLT=	.20	IALPHA=	0	NSPEED=	0	ICOPOS=	0	KIV=	0	ICRIT=	0	CUT=	.0	NOCASE=	
IPHI=	0	IFREQ=	0	IOVER=	2	JPLOT=	1	NF=	0	EIGN=	.00	IDEND=	0	IRWIND=	
ICUT=	0	ATEST=		IALT=	1	ICARD=	0	IHAM=	0	NERR=	2	KS2=	0	KERR=	

TITLE: IAP CLASS RUN (PROB. 2 - PLOTS)

INPUT FORMAT FOR DATA ON FORTRAN FILE
(3X,A6/11X,10I1)

NUMERIC ANSWER KEY GIVEN
1222133233

ALTERNATE RESPONSE CARD GIVEN
4. 3. 4. 4. 4. 4. 4. 4. 4. 4.

NUMBER OF ITEMS IS 10

FIRST RECORD READ ID IS 1
RESPONSES READ 2232233333

IAP : ITEM ANALYSIS PROGRAM

CONTROLLED ITEM

*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

IAP CLASS RUN (PROB. 2 - PLOTS)

ITEM INFORMATION			PROPORTION OF 225 SUBJECTS SELECTING EACH RESPONSE			
ITEM NUMBER	DIFFICULTY	OMITS	1	2	3	4
1	.107	.000	.107	.627	.249	.018
2	.698	.000	.231	.698	.071	
3	.551	.000	.138	.551	.284	.027
4	.444	.000	.044	.444	.440	.071
5	.156	.000	.156	.431	.369	.044
6	.271	.000	.218	.476	.271	.036
7	.422	.000	.027	.204	.422	.347
8	.502	.000	.062	.502	.387	.049
9	.524	.000	.044	.369	.524	.062
10	.476	.000	.084	.280	.476	.160

AD-A107 884 AIR FORCE HUMAN RESOURCES LAB BROOKS AFB TX F/G 5/10
ITEM ANALYSIS PROGRAM (IAP) FOR ACHIEVEMENT TESTS.(U)
OCT 81 J B KOPLYAY
UNCLASSIFIED AFHRL-TP-81-22 NL

END
DATE FILMED
1 82
DTIC

IAP : ITEM ANALYSIS PROGRAM

CONTROLLED ITEM

*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISI
AF HUMAN RESOURCES LABORATOR
AIR FORCE SYSTEMS COMMAND

IAP CLASS RUN (PROB. 2 - PLOTS)

THE FOLLOWING ITEMS FALL OUTSIDE OF THE SPECIFIED DIFFICULTY RANGE AND SHOULD BE ELIMINATED BECAUSE OF EXTREME DIFFICULTY/EASINES

EASY ITEMS ABOVE .80 DIFFICULT ITEMS BELOW .20

1
5

IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN (PROB. 2 - PLOTS)

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

SUMMARY OF TEST STATISTICS

VARIABLE	MEAN	S.E.	ST.DEV.	S.E.	SKEWNESS	S.E.	KURTOSIS	S.E.	NO. OF SUBJECTS
RAW SCORE	4.15	.10	1.48	.08	.22	.16	.37	.32	225

TEST RELIABILITY= .035

IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN (PROB. 2 - PLOTS)

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

ITEM ANALYSIS SUMMARY TABLE

ITEM	DIFFICULTY PROP'N.	DIFFICULTY STD.	STANDARD DEVIATION	BISERIAL CORR.	BISERIAL T-TEST	POINT BISERIAL CORR.	POINT BISERIAL T-TEST	X-FIFTY	BETA	REL. INDEX
1	.107	.299	.309	.251	3.872	.150	2.258	4.959	.259	.046
2	.698	.584	.459	.433	7.167	.329	5.197	-1.197	.480	.151
3	.551	.521	.497	.427	7.050	.340	5.392	-.301	.472	.169
4	.444	.477	.497	.379	6.118	.301	4.721	.368	.410	.150
5	.156	.336	.362	.436	7.241	.288	4.483	2.321	.485	.104
6	.271	.402	.445	.433	7.173	.323	5.092	1.408	.480	.143
7	.422	.468	.494	.496	8.529	.393	6.381	.396	.571	.194
8	.502	.501	.500	.346	5.500	.276	4.284	-.016	.368	.138
9	.524	.510	.499	.363	5.821	.290	4.518	-.169	.390	.145
10	.476	.490	.499	.587	10.823	.468	7.906	.104	.725	.234

MEAN STANDARDIZED ITEM DIFFICULTY = .459
CORRESPONDING PROPORTION = .399

IAP : ITEM ANALYSIS PROGRAM

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

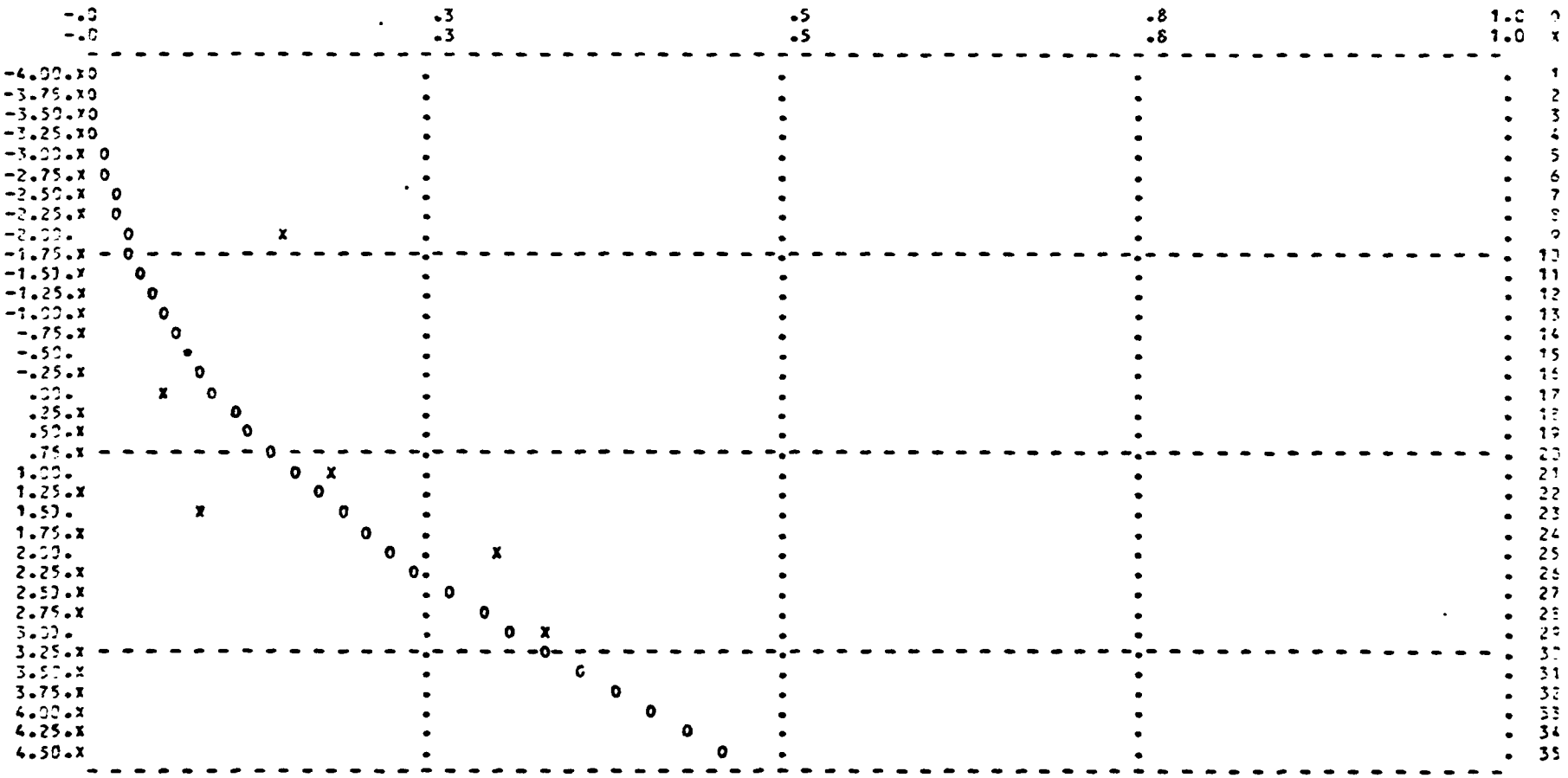
IAP CLASS RUN (PROB. 2 - PLOTS)

PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

ITEM	-4.0	-3.5	-3.0	-2.5	-2.0	-1.5	-1.0	-0.5	0.0	+0.5	+1.0	+1.5	+2.0	+2.5	+3.0	+3.5	+4.0	XFIFTY
1	.00	.00	.00	.00	.14	.00	.00	.08	.06	.00	.18	.09	.30	.00	.33	.00	.00	.00	4.96

SCALED ABSOLUTELY, MIN/MAX VALUES DEFINED BY CALLING PROGRAM.
ITEM CHARACTERISTIC CURVE

THEORETICAL PROPORTION AT -4.0 = .010



PLOT DESCRIPTION

TRACE	PLOT	CHARACTER	MINIMUM	MAXIMUM	RESOLUTION
1	FITTED VALUES	0	.000	1.000	.008
2	ACTUAL VALUES	x	.000	1.000	.008

IAP : ITEM ANALYSIS PROGRAM

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

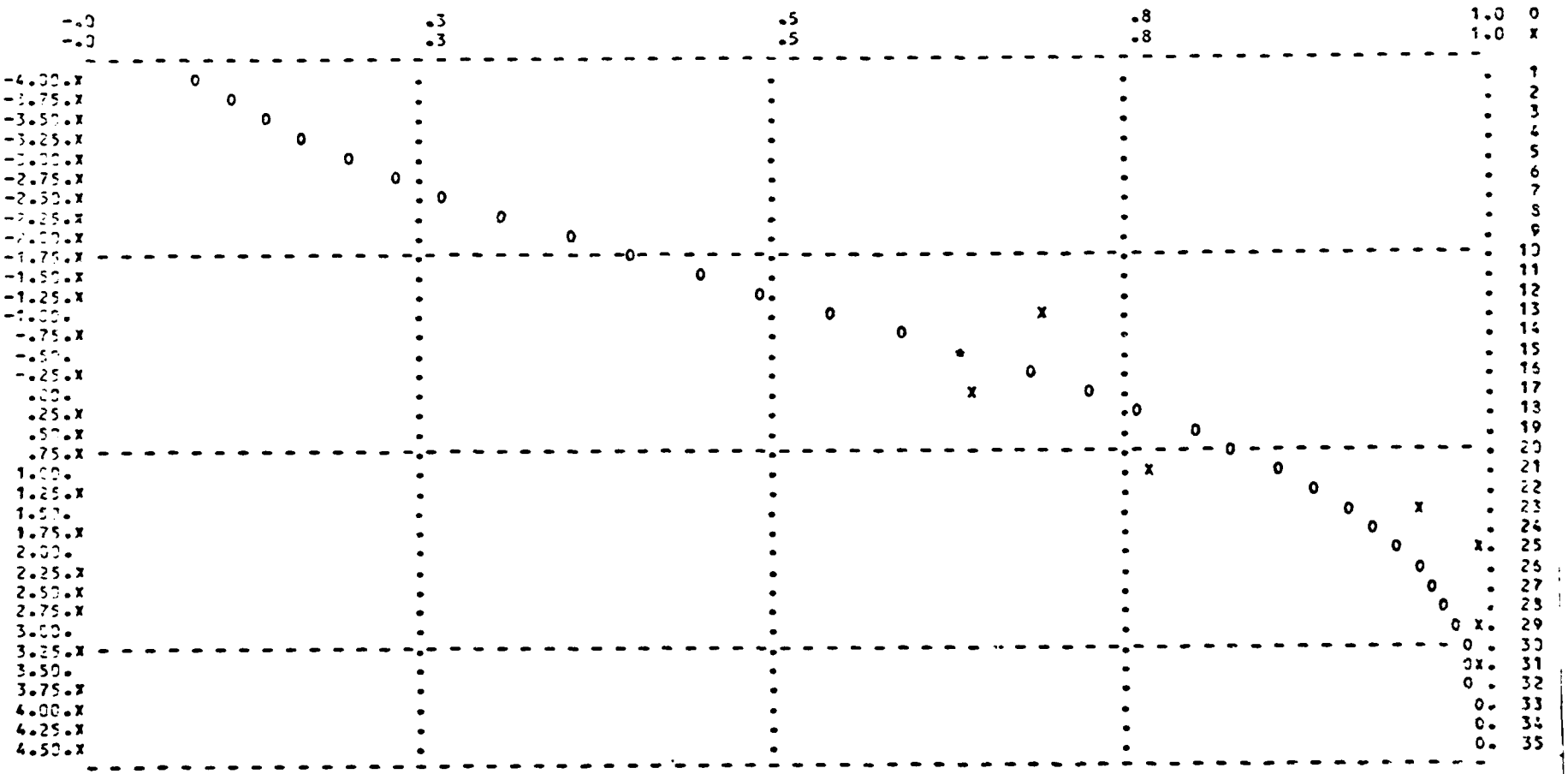
IAP CLASS RUN (PROB. 2 - PLOTS)

PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

ITEM	-4.0	-3.5	-3.0	-2.5	-2.0	-1.5	-1.0	-0.5	0.0	+0.5	+1.0	+1.5	+2.0	+2.5	+3.0	+3.5	+4.0	XFIFTY
2	.00	.00	.00	.00	.00	.03	.69	.63	.63	.00	.76	.95	1.00	.00	1.00	1.00	.00	.00	-1.20

SCALED ABSOLUTELY, MIN/MAX VALUES DEFINED BY CALLING PROGRAM.
ITEM CHARACTERISTIC CURVE

THEORETICAL PROPORTION AT -4.0 = .089



PLOT DESCRIPTION

TRACE	PLOT	CHARACTER	MINIMUM	MAXIMUM	RESOLUTION
1	FITTED VALUES	0	.000	1.000	.008
2	ACTUAL VALUES	X	.000	1.000	.008

IAP : ITEM ANALYSIS PROGRAM — CONTROLLED ITEM — MANPOWER AND PERSONNEL DIVISION

*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) *** — AF HUMAN RESOURCES LABORATORY

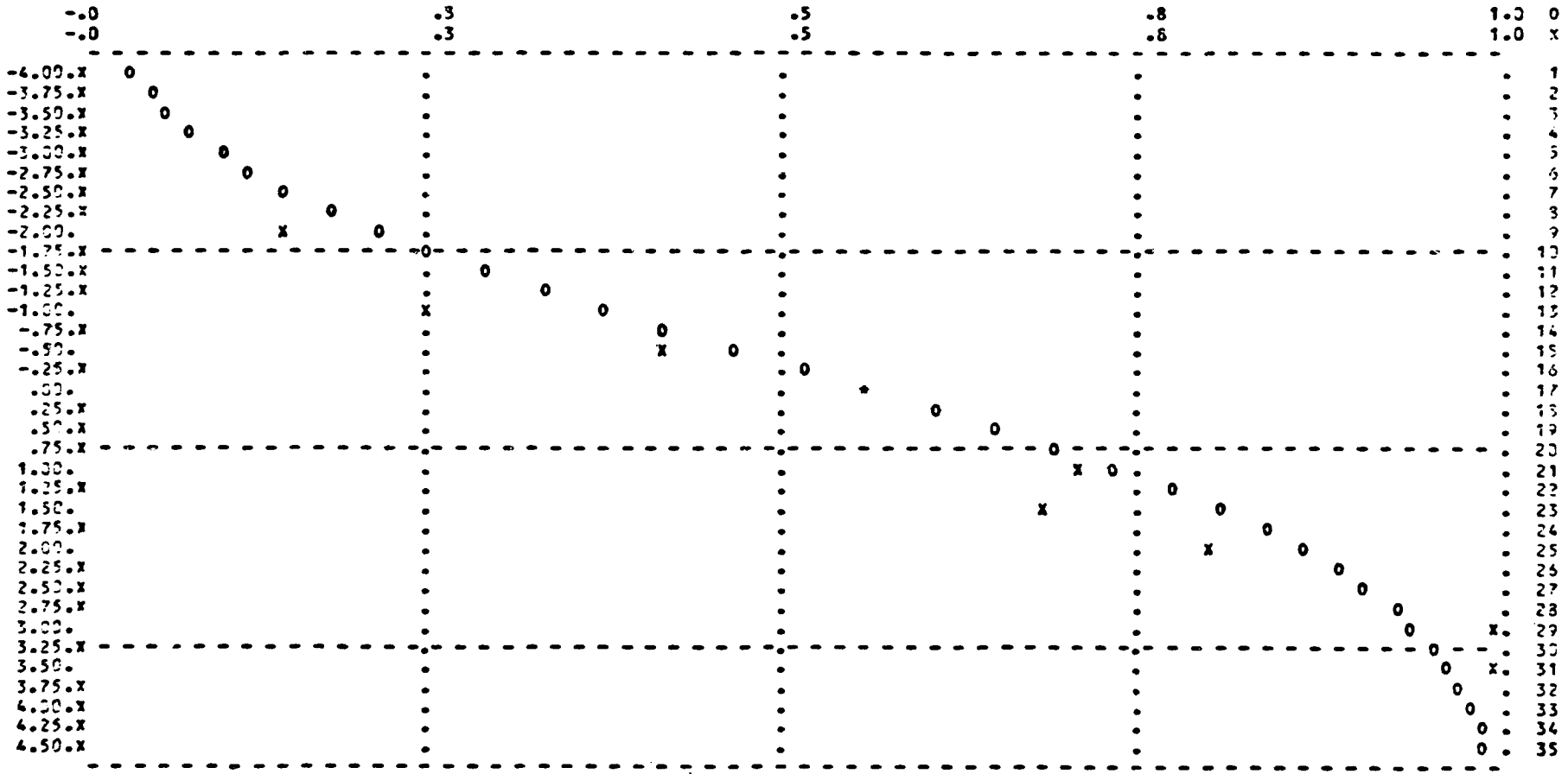
IAP CLASS RUN (PROB. 2 - PLOTS) — AIR FORCE SYSTEMS COMMAND

PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

ITEM	-4.0	-3.5	-3.0	-2.5	-2.0	-1.5	-1.0	-0.5	0.0	+0.5	+1.0	+1.5	+2.0	+2.5	+3.0	+3.5	+4.0	XFIFTY
3	.00	.00	.00	.00	.14	.00	.25	.41	.56	.00	.71	.68	.80	.00	1.00	1.00	.00	.00	-.30

SCALED ABSOLUTELY, MIN/MAX VALUES DEFINED BY CALLING PROGRAM.

ITEM CHARACTERISTIC CURVE — THEORETICAL PROPORTION AT -4.0 = .040



PLOT DESCRIPTION

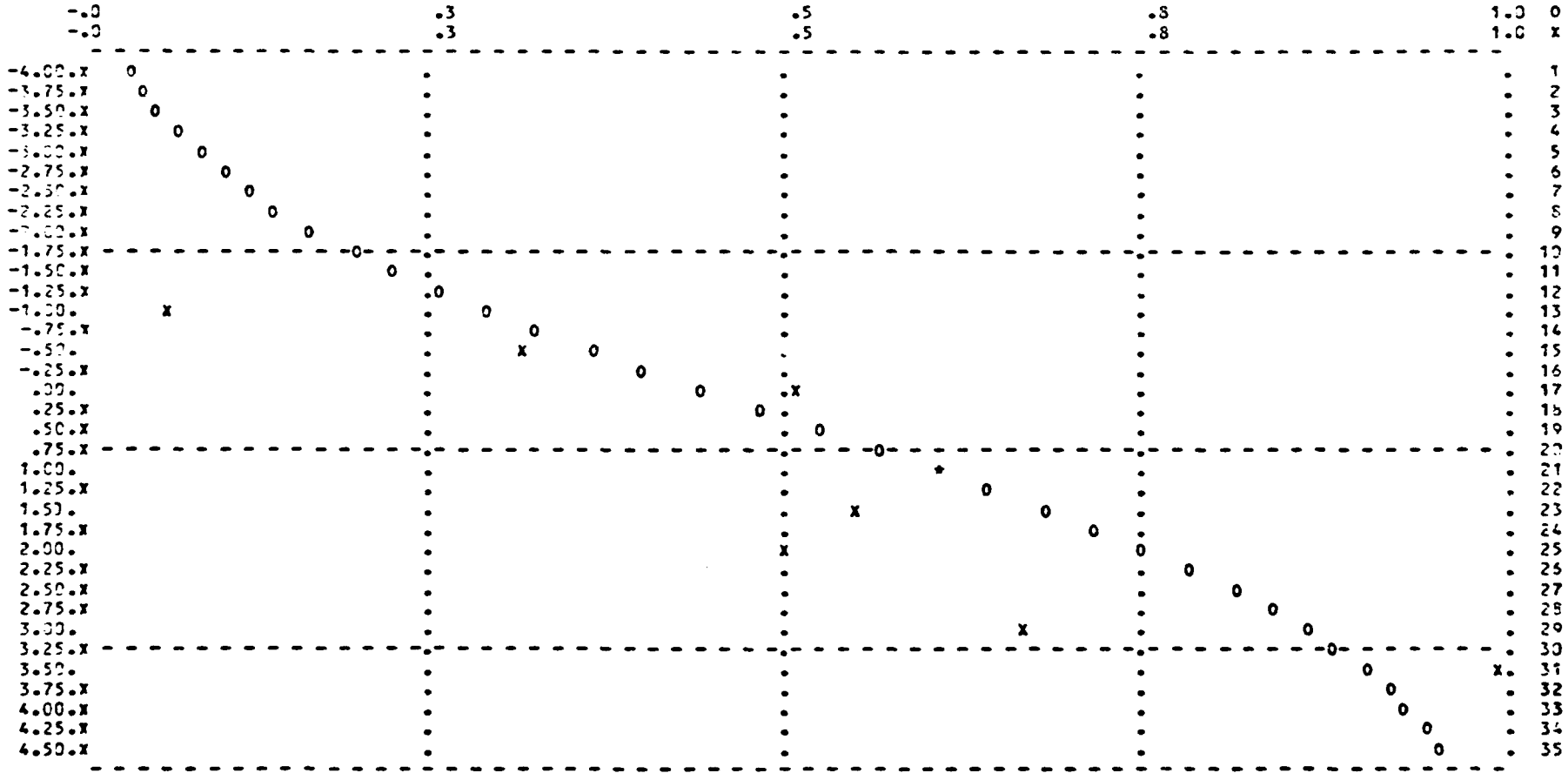
TRACE	PLOT	CHARACTER	MINIMUM	MAXIMUM	RESOLUTION
1	FITTED VALUES	0	.000	1.000	.003
2	ACTUAL VALUES	X	.000	1.000	.008

IAP : ITEM ANALYSIS PROGRAM — CONTROLLED ITEM — MANPOWER AND PERSONNEL DIVISION
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) *** — AF HUMAN RESOURCES LABORATORY
IAP CLASS RUN (PROB. 2 - PLOTS) — AIR FORCE SYSTEMS COMMAND

PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

ITEM	-4.0	-3.5	-3.0	-2.5	-2.0	-1.5	-1.0	-0.5	0.0	+0.5	+1.0	+1.5	+2.0	+2.5	+3.0	+3.5	+4.0	XFIFTY
4	.00	.00	.00	.00	.00	.00	.06	.31	.51	.00	.61	.55	.50	.00	.67	1.00	.00	.00	.37

SCALED ABSOLUTELY, MIN/MAX VALUES DEFINED BY CALLING PROGRAM.
ITEM CHARACTERISTIC CURVE — THEORETICAL PROPORTION AT -4.0 = .037



PLOT DESCRIPTION

TRACE	PLOT	CHARACTER	MINIMUM	MAXIMUM	RESOLUTION
1	FITTED VALUES	0	.000	1.000	.008
2	ACTUAL VALUES	X	.000	1.000	.008

IAP : ITEM ANALYSIS PROGRAM — CONTROLLED ITEM — MANPOWER AND PERSONNEL DIVISION

*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) *** — AF HUMAN RESOURCES LABORATORY

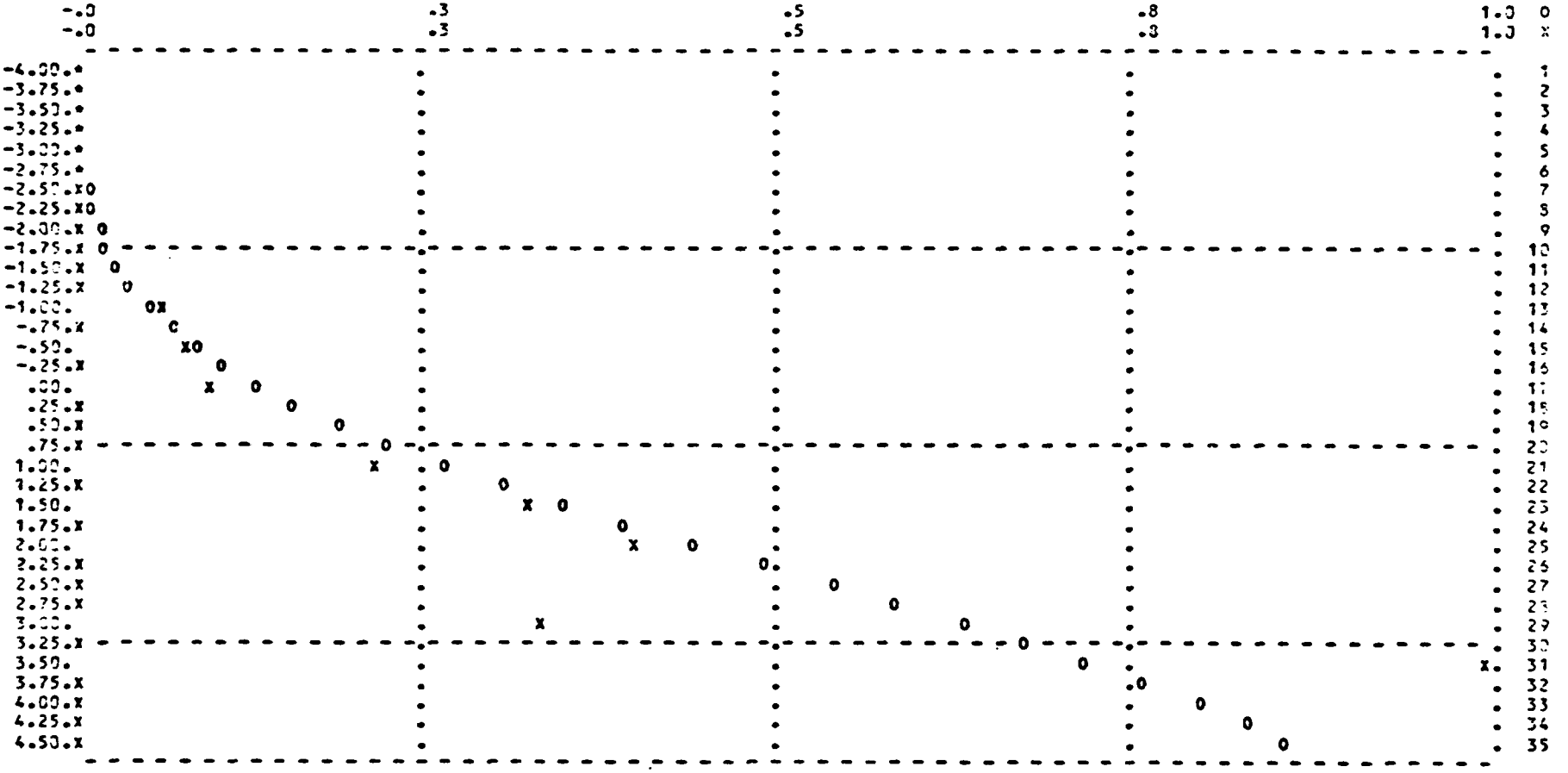
IAP CLASS RUN (PROB. 2 - PLOTS) — AIR FORCE SYSTEMS COMMAND

PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

ITEM	-4.0	-3.5	-3.0	-2.5	-2.0	-1.5	-1.0	-0.5	0.0	+0.5	+1.0	+1.5	+2.0	+2.5	+3.0	+3.5	+4.0	XFIFTY
5	.00	.00	.00	.00	.00	.00	.06	.08	.10	.00	.22	.32	.40	.00	.33	1.00	.00	.00	2.32

SCALED ABSOLUTELY, MIN/MAX VALUES DEFINED BY CALLING PROGRAM.

ITEM CHARACTERISTIC CURVE — THEORETICAL PROPORTION AT -4.0 = .001



PLOT DESCRIPTION

TRACE	PLOT	CHARACTER	MINIMUM	MAXIMUM	RESOLUTION
1	FITTED VALUES	0	.000	1.000	.008
2	ACTUAL VALUES	X	.000	1.000	.008

IAP = ITEM ANALYSIS PROGRAM

CONTROLLED ITEM

*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

IAP CLASS RUN (PROB. 2 - PLOTS)

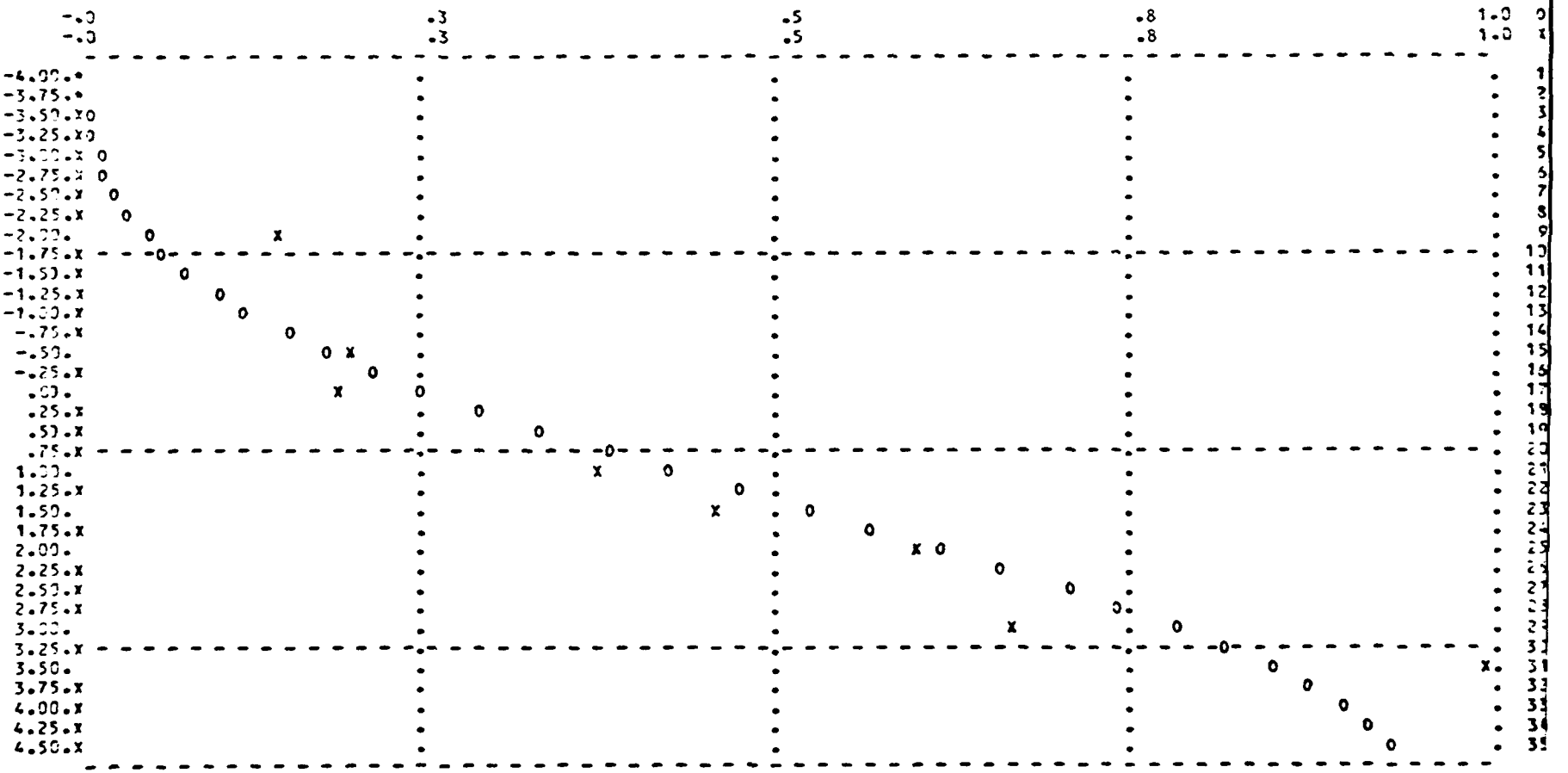
PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

ITEM	-4.0	-3.5	-3.0	-2.5	-2.0	-1.5	-1.0	-0.5	0.0	+0.5	+1.0	+1.5	+2.0	+2.5	+3.0	+3.5	+4.0	XFIFTY
6	.00	.00	.00	.00	.14	.00	.00	.20	.19	.00	.37	.45	.60	.00	.67	1.00	.00	.00	1.41

SCALED ABSOLUTELY, MIN/MAX VALUES DEFINED BY CALLING PROGRAM.

ITEM CHARACTERISTIC CURVE

THEORETICAL PROPORTION AT -4.0 = .005



101

PLOT DESCRIPTION

TRACE	PLOT	CHARACTER	MINIMUM	MAXIMUM	RESOLUTION
1	FITTED VALUES	0	.000	1.000	.008
2	ACTUAL VALUES	X	.000	1.000	.008

IAP : ITEM ANALYSIS PROGRAM

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

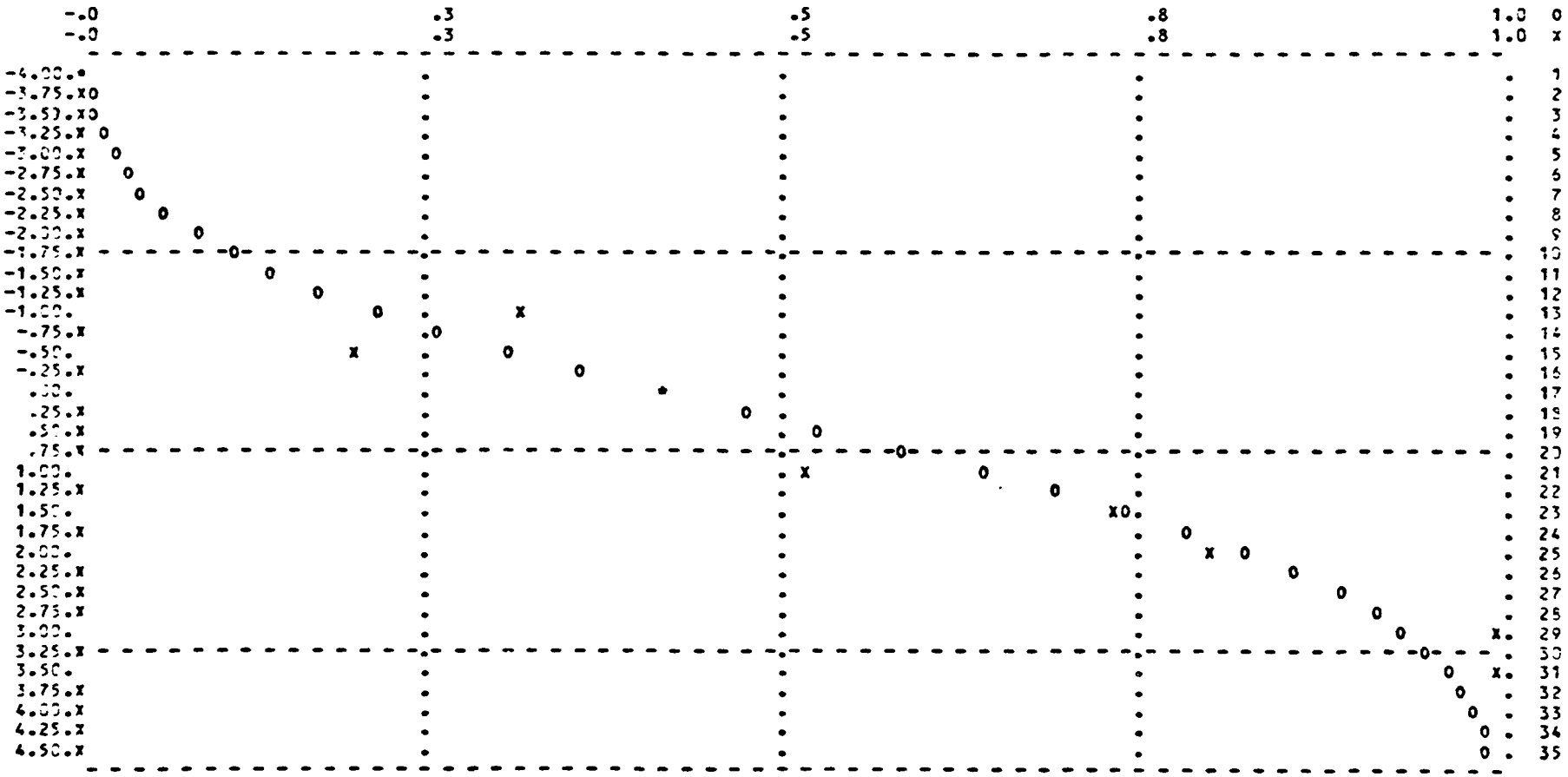
IAP CLASS RUN (PROB. 2 - PLOTS)

PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

ITEM	-4.0	-3.5	-3.0	-2.5	-2.0	-1.5	-1.0	-0.5	0.0	+0.5	+1.0	+1.5	+2.0	+2.5	+3.0	+3.5	+4.0	XFIFTY
7	.00	.00	.00	.00	.00	.00	.31	.20	.41	.00	.51	.73	.80	.00	1.00	1.00	.00	.00	.40

SCALED ABSOLUTELY. MIN/MAX VALUES DEFINED BY CALLING PROGRAM.
ITEM CHARACTERISTIC CURVE

THEORETICAL PROPORTION AT -4.0 = .006



PLOT DESCRIPTION

TRACE	PLOT	CHARACTER	MINIMUM	MAXIMUM	RESOLUTION
1	FITTED VALUES	O	.000	1.000	.008
2	ACTUAL VALUES	X	.000	1.000	.008

CONTROLLED ITEM
*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) ***

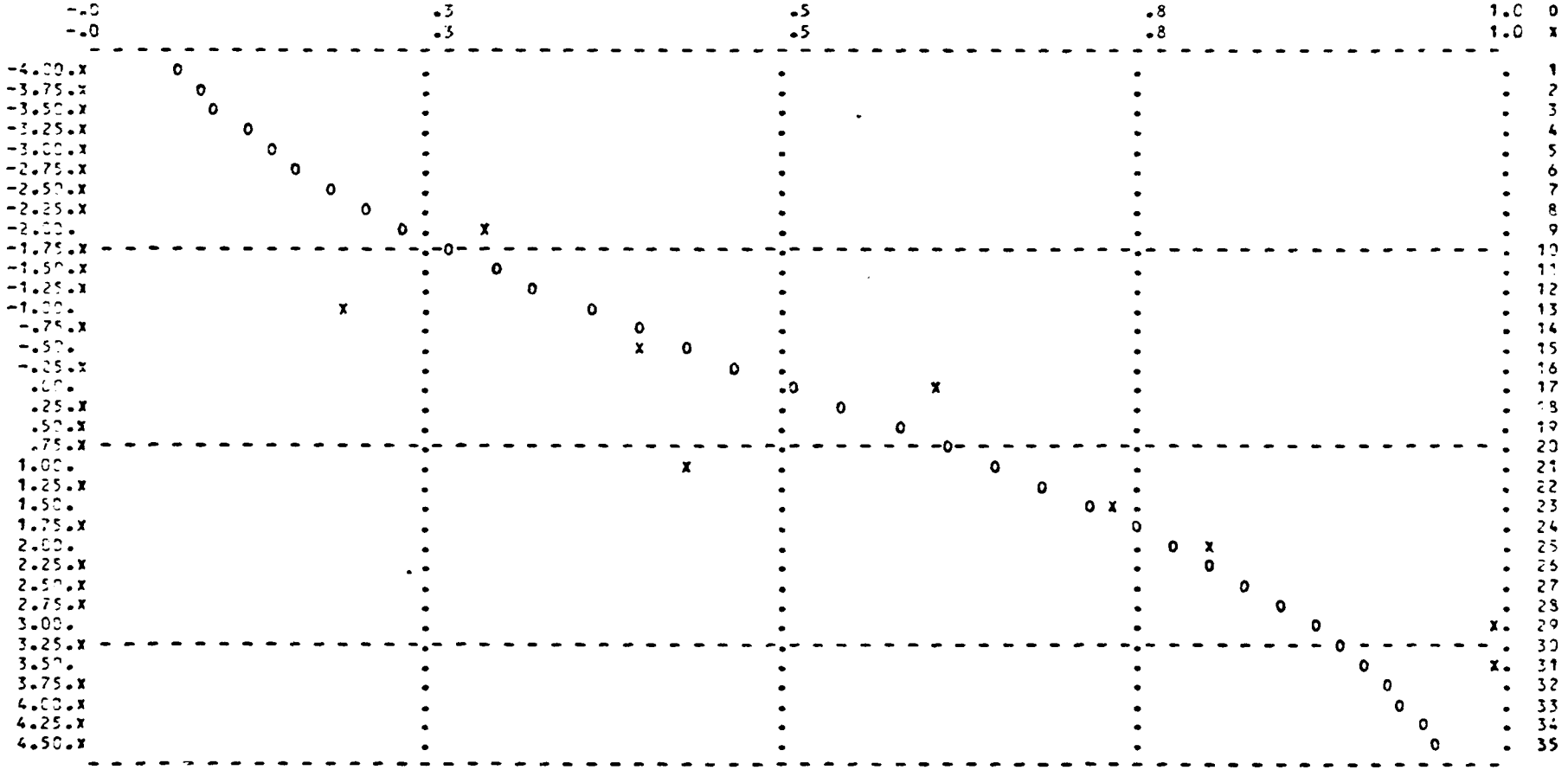
MANPOWER AND PERSONNEL DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

ITEM	-4.0	-3.5	-3.0	-2.5	-2.0	-1.5	-1.0	-0.5	0.0	+0.5	+1.0	+1.5	+2.0	+2.5	+3.0	+3.5	+4.0	XFIFTY
8	.00	.00	.00	.00	.29	.00	.19	.39	.60	.00	.43	.73	.80	.00	1.00	1.00	.00	.00	-.02

SCALED ABSOLUTELY, MIN/MAX VALUES DEFINED BY CALLING PROGRAM.
ITEM CHARACTERISTIC CURVE

THEORETICAL PROPORTION AT -4.0 = .071



PLOT DESCRIPTION

TRACE	PLOT	CHARACTER	MINIMUM	MAXIMUM	RESOLUTION
1	FITTED VALUES	0	.000	1.000	.008
2	ACTUAL VALUES	X	.000	1.000	.008

IAP : ITEM ANALYSIS PROGRAM — CONTROLLED ITEM — MANPOWER AND PERSONNEL DIVISION

*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) *** — AF HUMAN RESOURCES LABORATORY

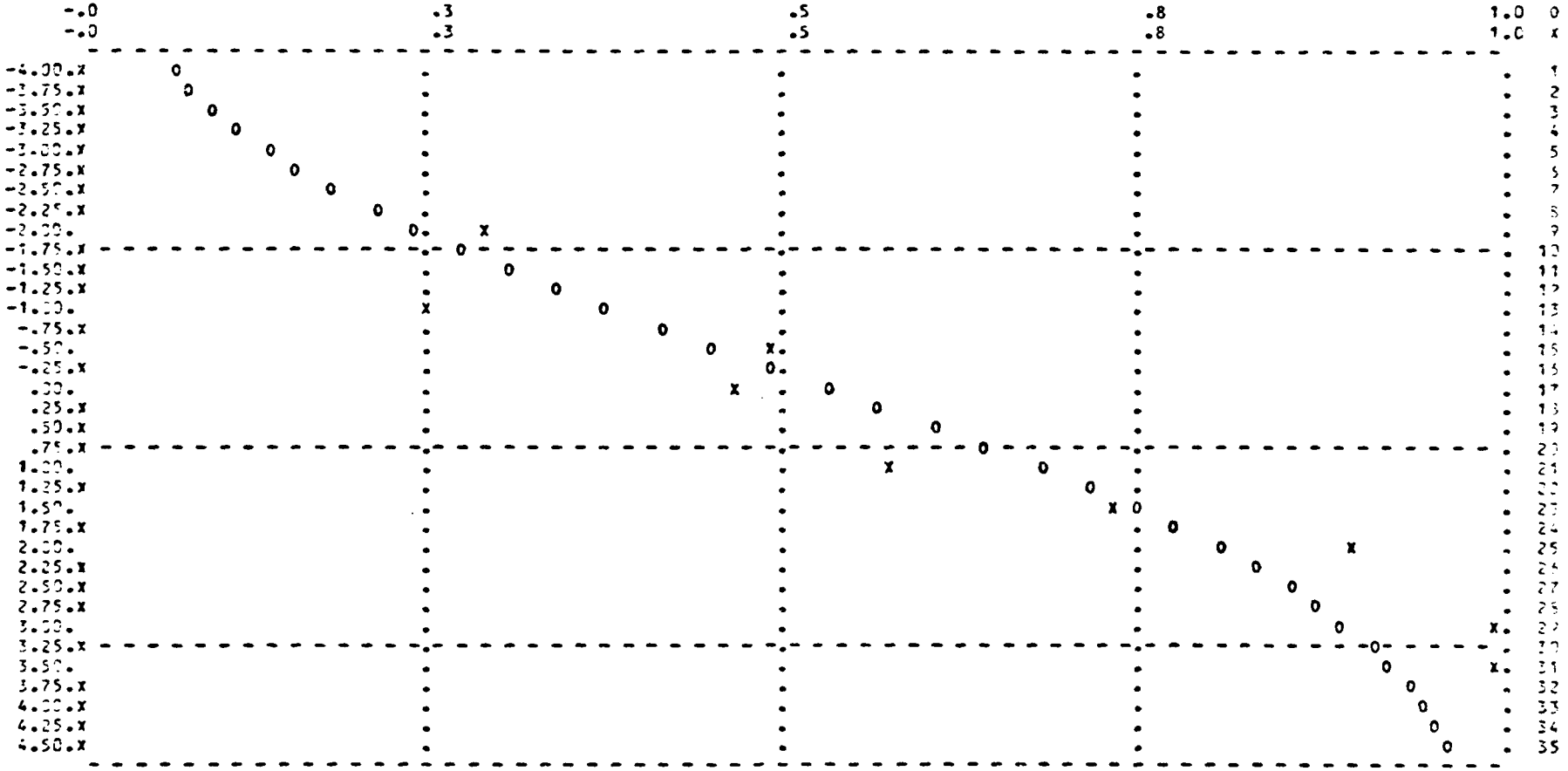
IAP CLASS RUN (PROB. 2 - PLOTS) — AIR FORCE SYSTEMS COMMAND

PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

ITEM	-4.0	-3.5	-3.0	-2.5	-2.0	-1.5	-1.0	-0.5	0.0	+0.5	+1.0	+1.5	+2.0	+2.5	+3.0	+3.5	+4.0	%FIFTY
9	.00	.00	.00	.00	.29	.00	.25	.49	.46	.00	.57	.73	.90	.00	1.00	1.00	.00	.00	-.17

SCALED ABSOLUTELY, MIN/MAX VALUES DEFINED BY CALLING PROGRAM.

ITEM CHARACTERISTIC CURVE — THEORETICAL PROPORTION AT -4.0 = .068



PLOT DESCRIPTION

TRACE	PLOT	CHARACTER	MINIMUM	MAXIMUM	RESOLUTION
1	FITTED VALUES	0	.000	1.000	.008
2	ACTUAL VALUES	X	.000	1.000	.008

[illegible] ITEM ANALYSIS PROGRAM — [illegible] ITEM — [illegible] AND PERSONNEL DIVISION

*** PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) *** — AF HUMAN RESOURCES LABORATORY

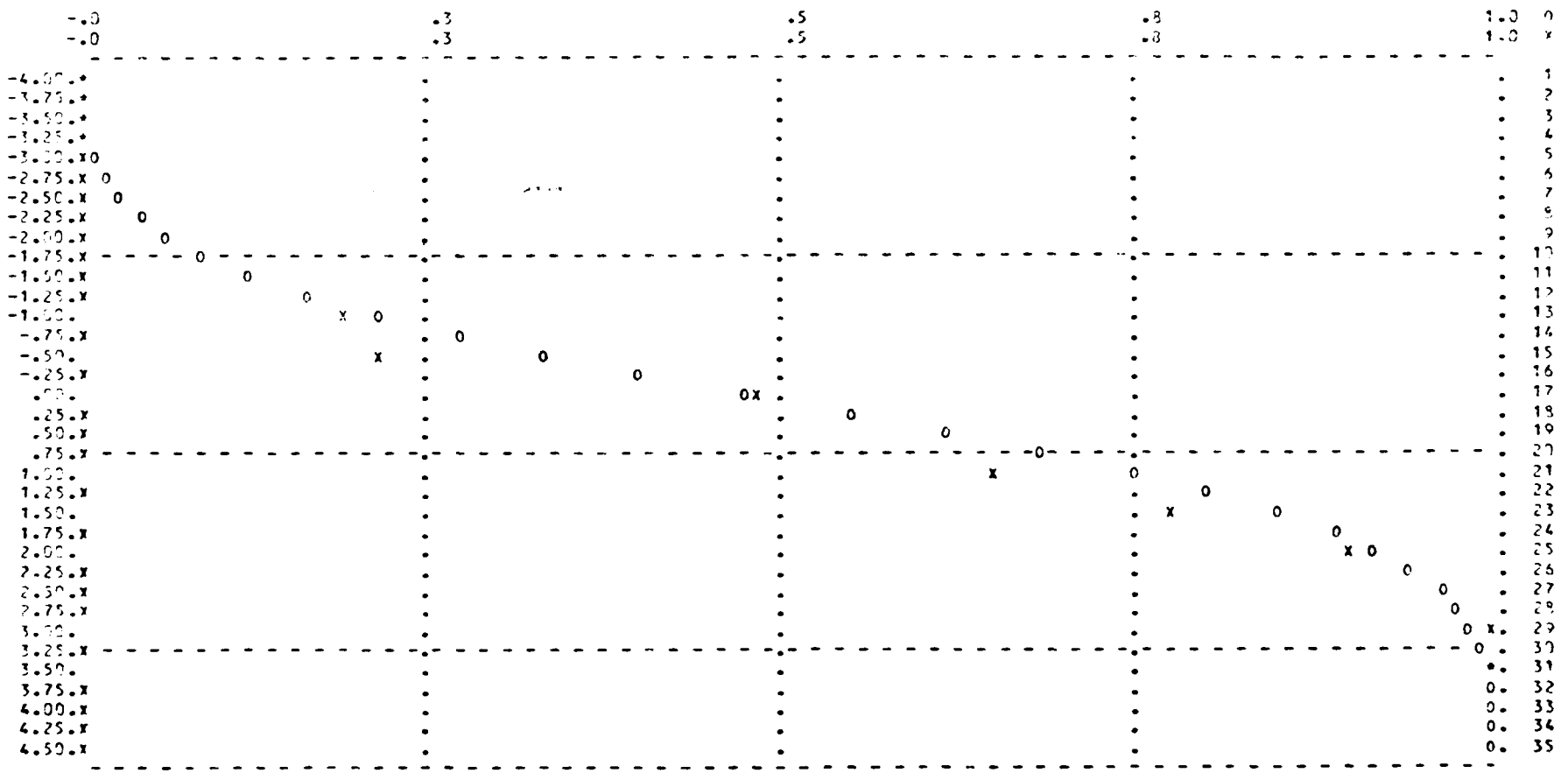
ISP CLASS RUN (P900, 2 - PLOTS) — AIR FORCE SYSTEMS COMMAND

PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

ITEM	-4.0	-3.5	-3.0	-2.5	-2.0	-1.5	-1.0	-0.5	0.0	+0.5	+1.0	+1.5	+2.0	+2.5	+3.0	+3.5	+4.0	DIFFICULTY
10	.00	.00	.00	.00	.00	.00	.19	.22	.48	.00	.65	.77	.90	.00	1.00	1.00	.00	.00	.10

SCALED ABSOLUTELY, MIN/MAX VALUES DEFINED BY CALLING PROGRAM.

ITEM CHARACTERISTIC CURVE — THEORETICAL PROPORTION AT -4.0 = .001



PLOT DESCRIPTION

TRACE	PLOT	CHARACTER	MINIMUM	MAXIMUM	RESOLUTION
1	FITTED VALUES	0	.000	1.000	.008
2	ACTUAL VALUES	X	.000	1.000	.008

END OF IAP PASS.

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                    END OF IAP RUN.          RUN TIME =     109(CLOCK)/      21(CPU) SECONDS.

@FREE  TEMP.
READY

@FREE  DA*IAPCLASSDATA.
READY

@BRKPT  PRINTS
```